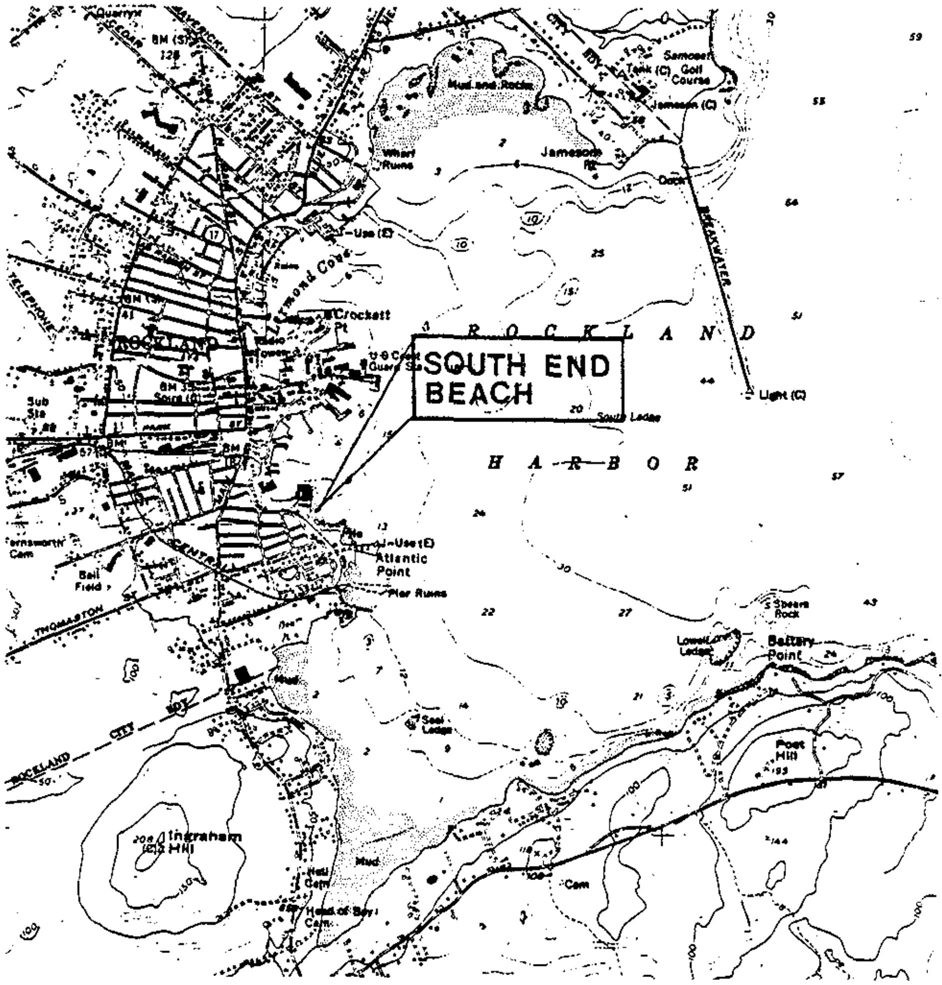
Detailed Project Report
And Environmental Assessment
Small Beach Erosion Control Project

South End Beach
Rockland, Maine



US Army Corps of Engineers
New England Division

EXECUTIVE SUMMARY

Rockland is a small coastal city located at the southwestern side of Penobscot Bay, midway along the Maine coast. South End Beach, a narrow protective beach at the south end of the main waterfront at Rockland Harbor, fronts along the steep embankment of an abandoned railroad spur line, which in turn is fronted by a city-owned picnic and park area near the southern end of the beach. This report, prepared under the authority contained in Section 103 of the 1962 River and Harbor Act, as amended, presents several structural alternatives for restoring the municipal protective beach.

The problem at South End Beach is erosion of adjacent upland by wave action at high water levels and decrease in dry beach area. The dry beach area at high tide varies from 10 feet wide at the northern end to zero at the southern end. The present rate of erosion at the beach is approximately 1 foot per year. There is no existing berm (flat shelf) along the steep outer slope of the beach. Storm-induced erosion is occurring at the foot of the 12-foot-high embankment. Opportunity exists to stabilize the existing shoreline, prevent this erosion and restore the width of the beach area.

As the result of evaluation of alternative protective measures, a public involvement program, together with close coordination with city, State and Federal agencies, a plan of improvement is recommended that would restore the protective beach space and provide backshore protection. The recommended plan (Plan 1 and the National Economic Development plan) entails Federal participation in widening the existing beach by direct placement of an estimated 27,000 cubic yards of suitable sandfill along 450 feet of shorefront. The improvement would provide a 50-foot-wide, level-beach berm of elevation 15 feet above mean low water for a useable dry beach width of 140 feet above the mean high water line. The project would also entail construction of a 180-foot-long rock groin structure at the south end of the beach and replacement of existing riprap along the embankment at the north end of the beach, which would require an estimated 2,250 tons of stone. Periodic nourishment of the beach (estimated to cost $4,500 annually, of which the Federal share would be 50 percent) would be accomplished as needed during the 50-year evaluated life of the project.

The estimated first cost of the project is $400,000. The Federal share, 50 percent of the first cost, would be $200,000 and the non-Federal share would be $200,000. Annual project benefits of $81,500 for the recreational beach area compared with total annual charges of $35,800 provide a benefit-cost ratio of 3.3. The findings of this report are subject to the approval of the Chief of Engineers.

SOUTH END BEACH
ROCKLAND, MAINE
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I. GENERAL

A. INTRODUCTION

South End Beach is located in Rockland Harbor, Rockland, Maine. Rockland Harbor is near the mouth of Penobscot Bay on the west shore. This is approximately midway along the Maine Coast. The beach, as indicated by it's name, is located near the south end of the main business district off Scott Street and just north of Atlantic Point. (See Figures 1 and 2).

In an April 1982 letter the city of Rockland requested Corps of Engineers assistance in preparing reconnaissance reports on the potential for reducing erosion and providing recreational beaches at the Rockland Breakwater and South End Beach.

The Corps responded to this request and in September 1983 completed an Initial Appraisal Report on South End Beach. That report recommended that this Detailed Project Study be undertaken.

B. STUDY SCOPE AND PURPOSE

This study evaluates the erosion conditions along the 700-foot-long South End Beach and the immediately adjacent backland, defines problems, develops alternative plans for resolving the problems, investigates impacts with solutions or with no solutions, and recommends a plan and future course of action. Included are detailed analyses of the following:

- Existing beach profile and sediment analysis.
- Erosion rates.
- Winds, waves, and tidal flooding.
- Existing biological community.
- Alternative plans and cost estimates.
- Economic, environmental and social conditions.
- Economic, environmental and social impacts.
- Maintenance requirements.

C. STUDY AUTHORITY

This study was conducted under the authority granted in Section 103 of the River and Harbor Act of 1962, as amended for Small Beach Erosion Control Projects. Section 103 allows the Chief of Engineers to develop and construct small shore and beach restoration and protection protects. Only after a detailed investigation and study clearly shows engineering feasibility, environmental acceptability, economic justification and local support of a project will a recommendation for construction be forwarded. The Federal cost is limited to $1,000,000. This Federal cost limitation includes all project related costs for the Detailed Project Study, construction, supervision, administration, and periodic nourishment costs, if applicable. In addition, each project must be complete within

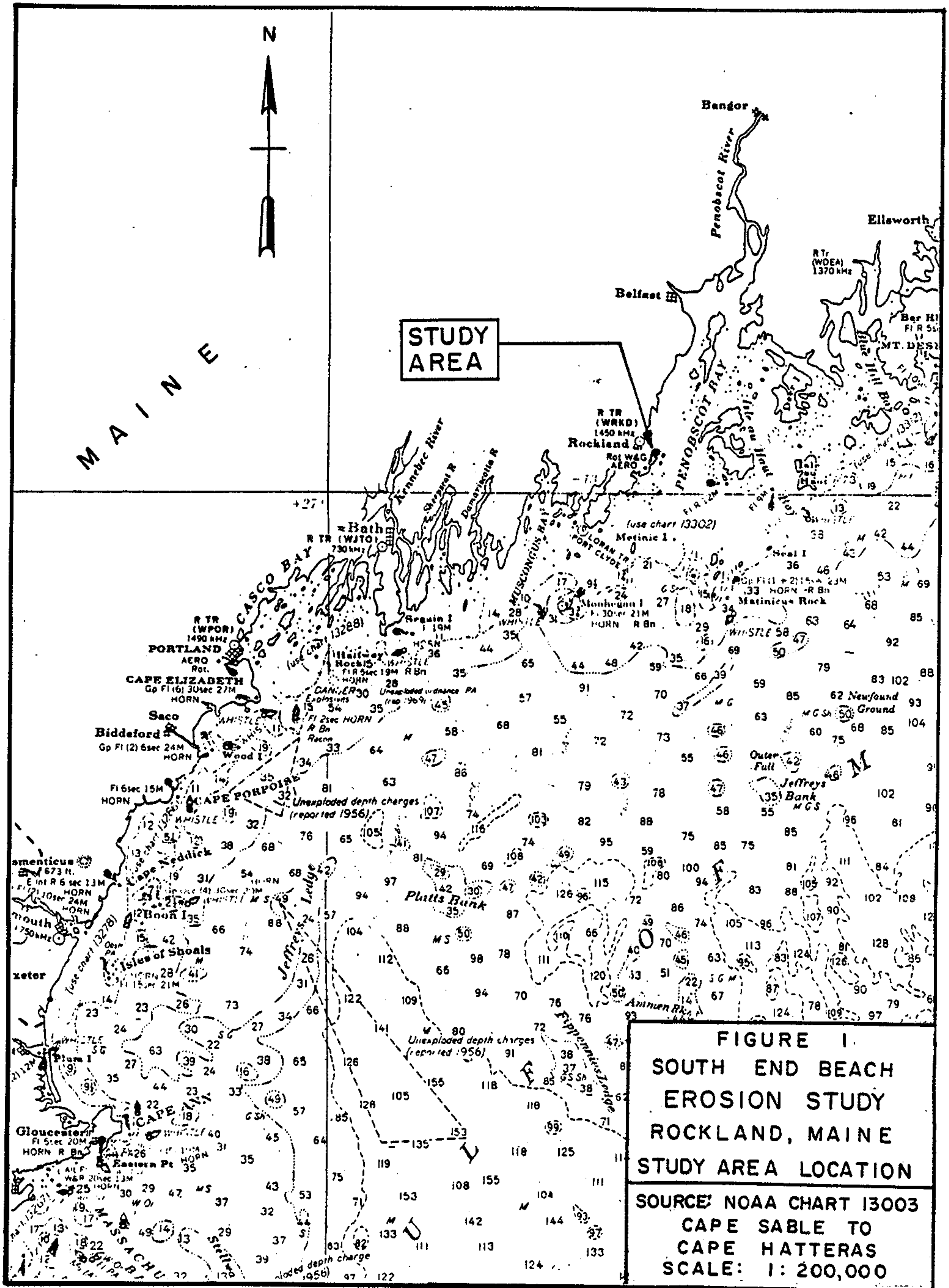

FIGURE 1

SOUTH END BEACH EROSION STUDY

ROCKLAND, MAINE

STUDY AREA LOCATION

SOURCE: NOAA CHART 13003 CAPE SABLE TO CAPE HATTERAS

SCALE: 1: 200,000

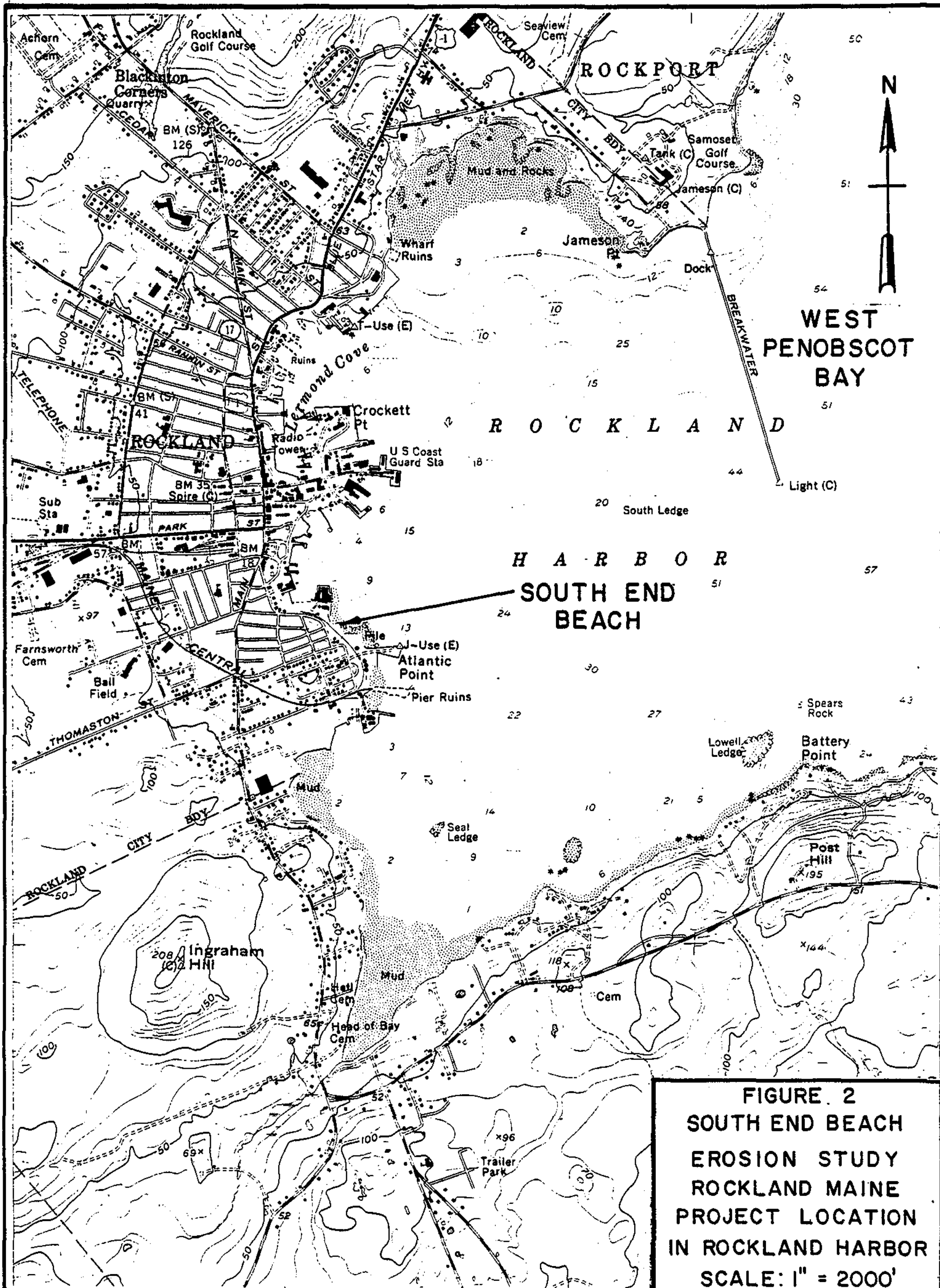

FIGURE. 2
SOUTH END BEACH
EROSION STUDY
ROCKLAND MAINE
PROJECT LOCATION
IN ROCKLAND HARBOR
SCALE: 1" = 2000'

itself. The problem must be solved without adversely impacting upon other areas, and in addition no additional work should be required to assure effective and successful operation of the project.

D. PLANNING CRITERIA

This section provides general guidance within which the study was conducted. Some of these are required by regulation while others are specific with respect to the project.

1. <u>National Objective</u>

The plans and their options were evaluated by establishing the contributions of each alternative to the planning objectives for beach erosion control projects. The National Objective is to satisfy the National Economic Development (NED). Consideration was also given to the Environmental Quality (EQ), and Other Social Effects (OSE) accounts. Desirability of the plans and options depended upon the beneficial and adverse impacts to the planning objectives for the study area.

The national objective for water resource planning was applied in evaluating the plans. Accordingly, the plan that resulted in the maximum net economic return was designated the NED Plan. Consideration was given to the following:

National Economic Development increases the nation's output of goods and services and improves its economic efficiency. This is accomplished by:

- Prevention of land loss and other physical damages;
- Reduction in maintenance costs;
- Increased recreational usage;
- Employment benefits.

Environmental Quality objectives involve the enhancement of the environment through management, conservation, preservation, recreation, restoration, or improvement of the quality of certain natural, cultural, and ecological resources.

Social objectives consider the direct and indirect implications that would result from the proposed project on the population and their life style. Consideration was given to the following:

- Community disruption;
- Effects on health, safety, and community well-being;
- Effects on desired community growth;
- Effects on educational, cultural, and recreational opportunities;
- Effects on emergency preparedness;

. Effects on noise levels during construction or other conditions that would tend to raise the overall noise level of the area over the 50-year period of analysis.

2. Problems, Opportunities and Constraints

The problem at South End Beach is the erosion of adjacent upland by wave action at high water levels as well as a decrease in recreational dry beach.

The need is to prevent this erosion and increase the recreational beach area while minimizing harm to the environment at a cost affordable to the parties involved in implementing a solution.

Opportunity does exist to stabilize the existing shoreline, decrease loss of property and improve the aesthetic and recreational aspects of, and protect the environmental aspects of, South End Beach.

Based on the above, constraints were determined for consideration during the planning process. These concerns, relating to subjects such as natural conditions, social and environmental factors, economic limits and legal restrictions, are as follows:

(a) Avoid, or minimize adverse effects on nearshore fishing, clamming, and biologically productive areas.

(b) Avoid, or minimize adverse effects on adjacent shoreline configurations or offshore hydrography.

(c) Avoid unreasonable financial burdens on the resources of the city of Rockland.

(d) Avoid, or minimize adverse impacts to the adjacent backland and neighborhood.

II. EXISTING CONDITIONS

A. PHYSICAL

South End Beach is located just south of Rockland Center, within walking distance of the city business district. The area of study extends approximately 700 feet, 450 feet of which is usable beach frontage (See Figure 3). The beach is bordered on the north by an embankment of large granite blocks (see Figure 5) and on the southern end by a natural rocky headland known as Atlantic Point (see Figure 4). The beach is partially divided into two bathing areas by large rock outcrops extending from backshore to approximately mean low water. Dry beach space at high tide varies from 10 feet wide at the northern end, to zero near the southern point.

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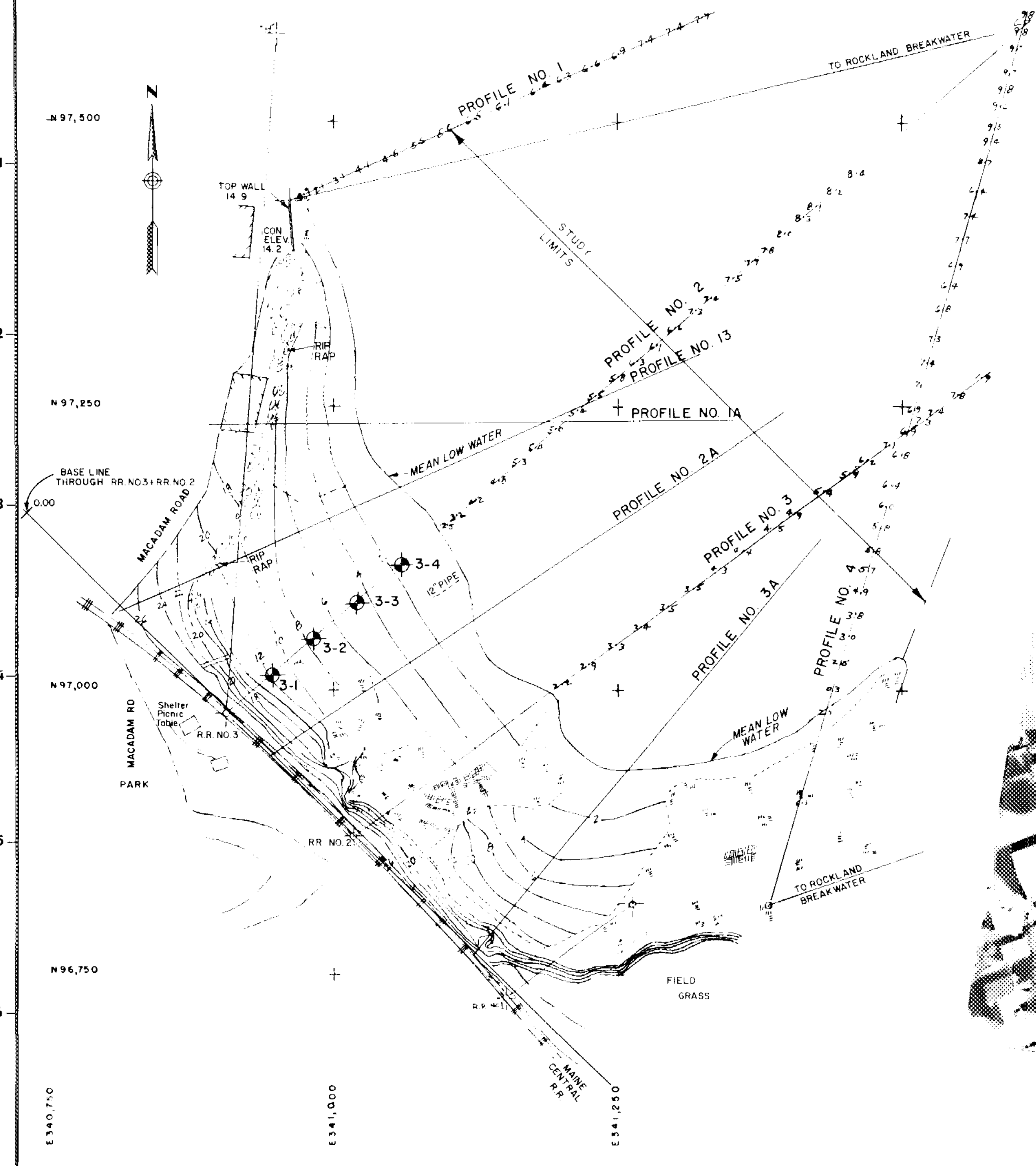


PLAN

AERIAL PHOTO

LEGEND

4.2	SPOT ELEVATION (BELOW M.L.W.)
—8—	EXISTING CONTOUR (ABOVE M.L.W.)
	BEDROCK OUTCROP
DATUM	MLW = 0.0
3-1	SOIL SAMPLE LOCATION

NOTES:

1. SURVEY WAS CONDUCTED AUGUST 1983.
2. PHOTO WAS TAKEN JUNE 24, 1978.
3. CONTOUR INTERVAL = 2'

GRAPHIC SCALE
1" = 50' 50' 0 50' 100'
SCALE IS APPROXIMATE ON PHOTO

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

SOUTH END BEACH EROSION STUDY

ROCKLAND, MAINE

EXISTING CONDITIONS, STUDY LIMITS

PROFILE AND SAMPLE LOCATIONS

OCTOBER 1985

FIGURE 3

FIGURE: 4 SOUTH END BEACH LOOKING SOUTH FROM NEAR NORTH END NEAR LOW TIDE

FIGURE: 5 DUMPED GRANITE BLOCK "REVETMENT" AT NORTH END OF BEACH

FIGURE: 6 TYPICAL VEGETATED BACKSLOPE. NOTE SLUMPING

The backshore is fronted by a steep embankment covered with grass and small bushes (see Figure 6). There is evidence of erosion during storm conditions when the water level is high, and waves undermine the toe of the embankment. Erosion from backland drainage is also present. Beyond the embankment is a park where a small picnic area with some tables and parking space has been developed (see Figure 9).

Behind the north end of the beach, there is presently an ineffective revetment composed of large randomly placed pieces of quarry rubble that were apparently dumped with no attempt to arrange the stones to maximize protection. Due to the lack of properly designed filter layers, there is evidence of erosion of the bank behind this revetment.

The foreshore consists of a gravelly, medium-to-coarse sand strewn with an abundance of shells, particularly at the southern end of the beach (see Figures 7 and 8). There is no existing berm on the beach and the slope of the beach from the toe of the embankment to the relatively level harbor bottom is approximately 1 vertical to 15 horizontal. Direct exposure to the open water of West Penobscot Bay is through a relatively narrow, 22 degree wide "window" to Vinalhaven Island. From the beach the optimum wave exposure is defined by lines drawn through the breakwater light and Owls Head. The average fetch to Vinalhaven Island is approximately 9.3 miles. Within Rockland Harbor the maximum fetch is approximately 1.6 miles to the northeast. Longer fetches exist from the harbor mouth to the northeast and southeast but waves from those directions are diffracted around the breakwater or Owls Head in order to reach South End Beach (see Figure 10).

Winds affecting the project area were determined by adjusting National Weather Service data recorded since 1948 at the Portland International Airport. Data indicates the prevailing direction for all winds is from the west-southwest, (WSW). While the principal onshore wind direction for all speed winds is from the east-northeast, there appears to be no persistent pattern of wind direction and velocity. The average annual wind speed is 8.8 mph from the south while the maximum fastest observed speed sustained for a 1 minute period was 76 mph from the northeast. All winds above 60 mph were from the eastern quadrant. Water depths in Rockland Harbor vary from zero at the shore to over 50 feet below mean low water (MLW) near the harbor entrance. Outside the harbor along the maximum fetch the depth drops to between 250 to 290 feet.

The project datum used in this report is mean low water (MLW). Based on this datum mean high water is at +9.7 feet and mean spring high water is at +10.5 feet. Tidal flood elevations are illustrated in Figure 11. This figure can be used to determine the stillwater elevation for storms having a certain probability of occurrence. For example, a storm which generates a stillwater elevation of +13.9 above MLW has an expected annual chance of occurrence of one in 10 years.

FIGURE: 7 ROCKY INTERTIDAL AREA AT SOUTH END OF BEACH

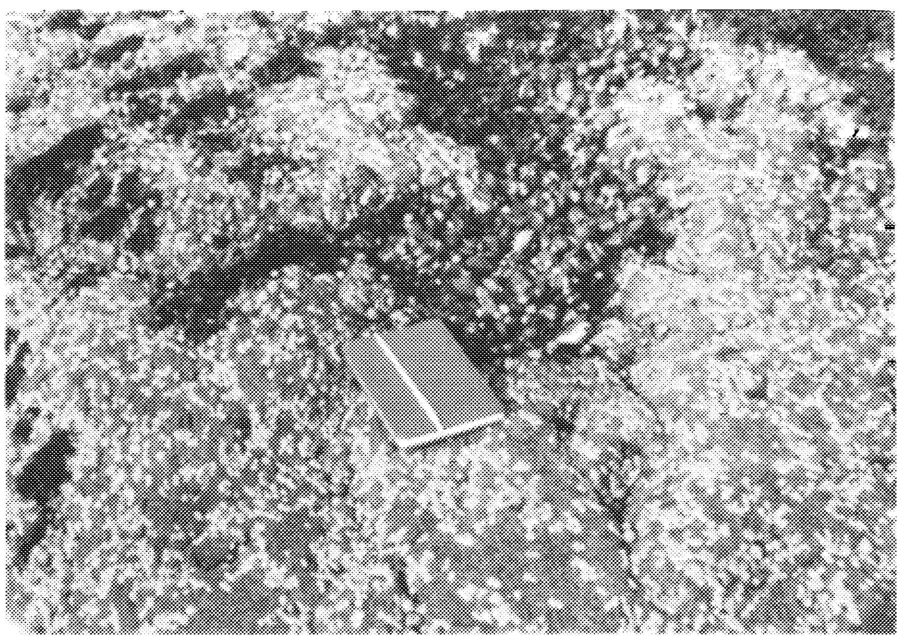


FIGURE: 8 TYPICAL INTERTIDAL OUTCROP COMMUNITY, BLUE MUSSELS, PERIWINKLES AND BARNACLES. NOTEBOOK IS 7.4"X4.7"

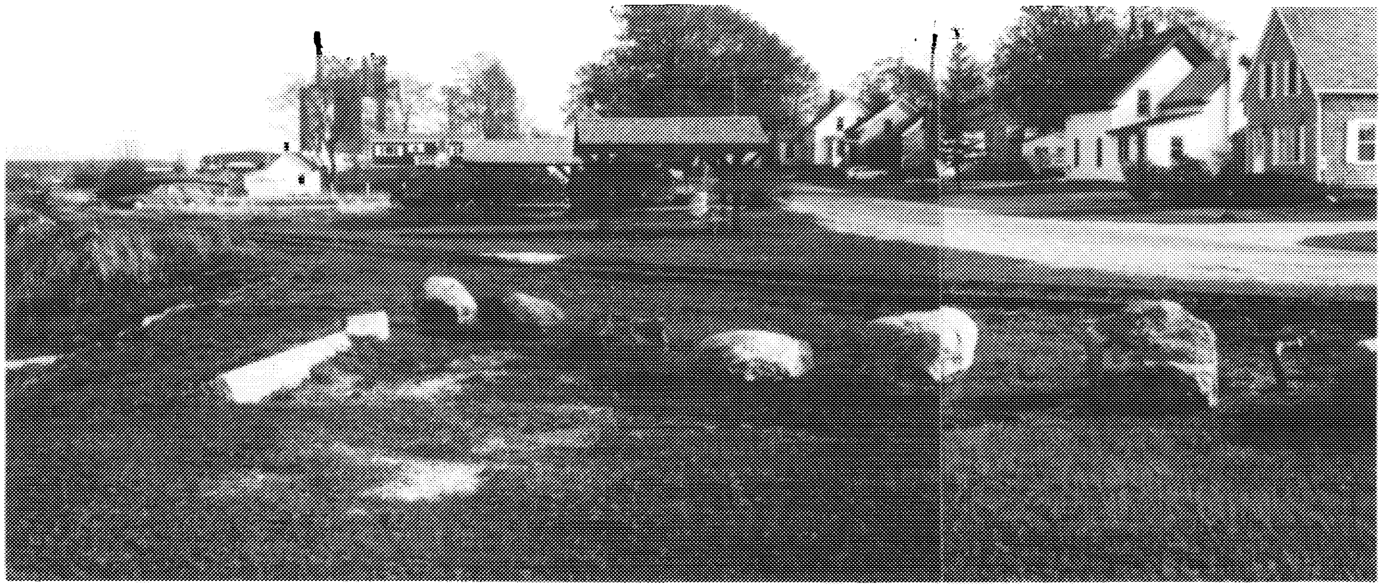


FIGURE: 9 PARK ON BACKLAND AREA
AT SOUTH END BEACH, LOOKING SOUTH

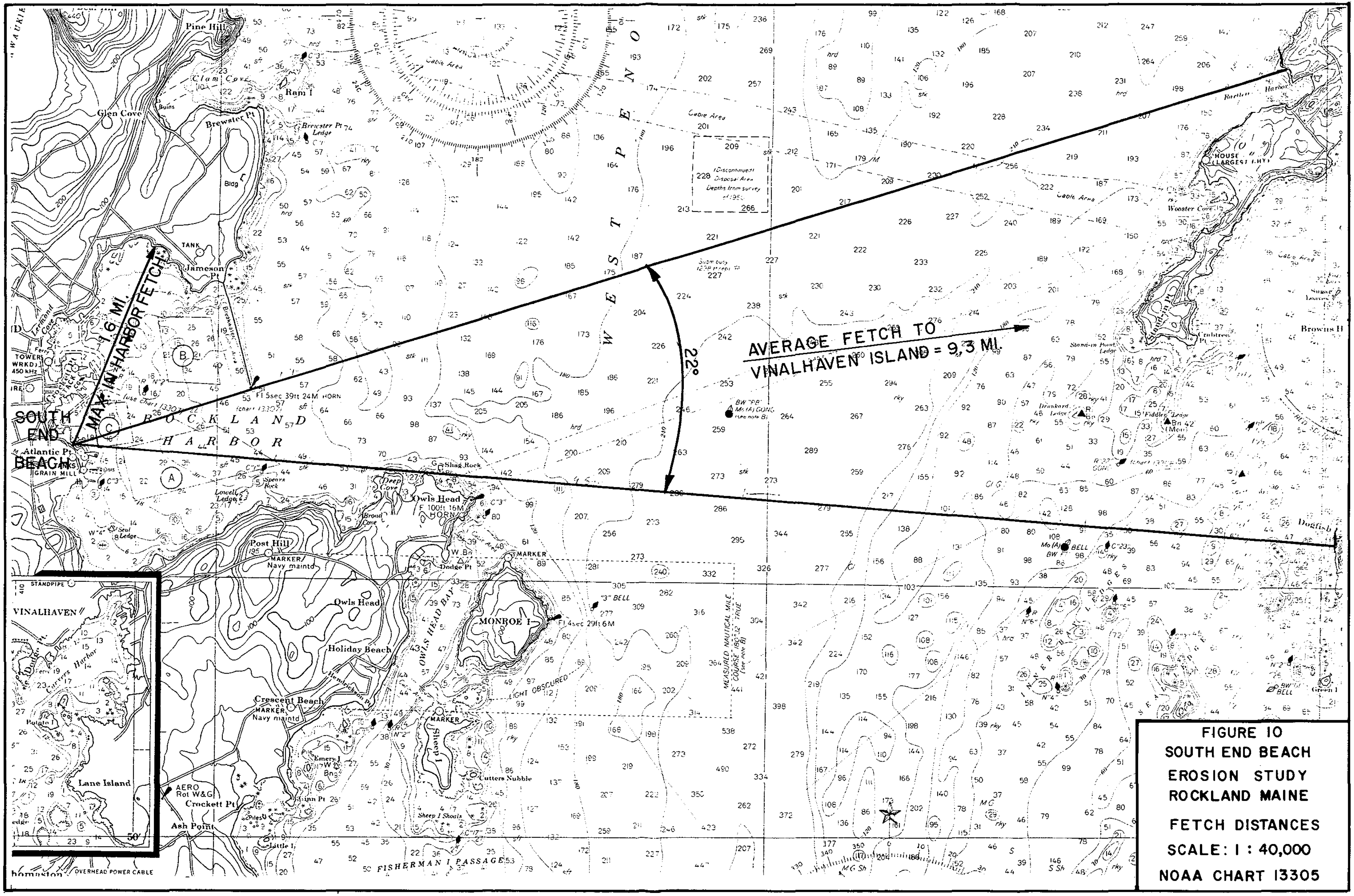


FIGURE 10
SOUTH END BEACH
EROSION STUDY
ROCKLAND MAINE

FETCH DISTANCES
SCALE: 1 : 40,000
NOAA CHART 13305

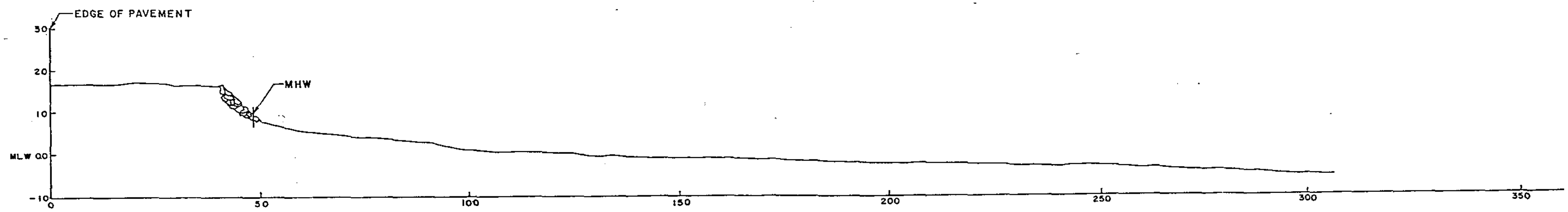
It can be seen from the above data, which is given in greater detail in the appendices, that at high tide, and during storms, the water level is near or above the toe of the upland slope. Waves superimposed on these high water levels are able to directly attack the backshore slope of unconsolidated material, and undercut it causing slumping and eventual failure.

A review of local historical records and the files of the Maine Central Railroad failed to provide any specific information with respect to the historic mean high water line. Because sea level in the area has risen approximately 1 foot in the last century and from evidence of active erosion of the existing bank, it is concluded the mean high water line was substantially further out than at present.

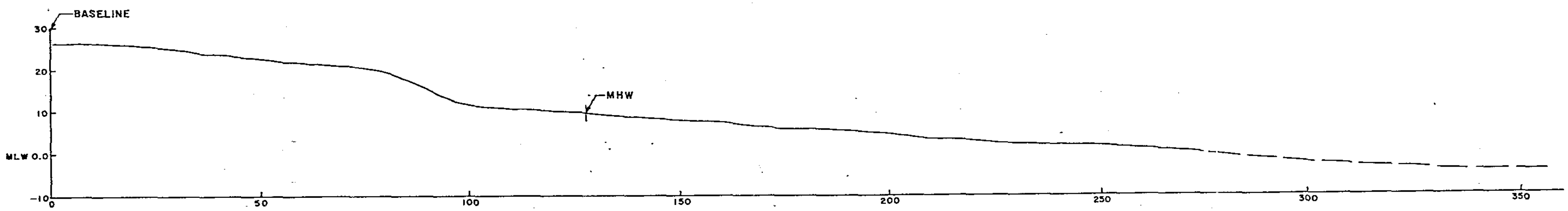
A series of profiles across the beach were made during the survey operations as shown in Figure 3 with interpolated intermediate profiles shown in Figures 14a and 14b. These portray in general a beach with no true berm and a relatively straight or slightly concave beach face with a slope of approximately 1 vertical on 15 horizontal. A series of samples were taken along profile #2 at the locations indicated in Figure 3. These samples, as discussed in Appendix 4, were subjected to grain size analyses, the combined results of which are illustrated in Figure 15. Sample 3-1, located above the mean high water mark shows a greater amount of fine sand than the samples on the beach face. It is primarily fine to medium sand with some coarse gravel and an absence of coarse sand and fine gravel. The three samples on the beach face between MHW and MLW are poorly sorted from fine to coarse sands and gravel. The size of material found on the beach is typical of a much steeper beach than presently exists.

The specific gravity of samples 3-2 and 3-3 was determined to be 2.69, which is somewhat higher than would be expected for a typical quartz sand. By visual observation, the beach material appeared to have a high shell content. A laboratory test was performed on sample 3-3 to determine this. The result indicated 38.5 percent of the sample by weight was shell fragments. This indicates that while bank erosion supplies most of the beach material, particularly the coarse material, the adjacent mussel beds and other shellfish areas are significant sources of beach material. Shell material typically has a specific gravity about 2.69. The shell material is more easily abraded and eventually lost but is naturally replenished from the adjacent mussel beds.

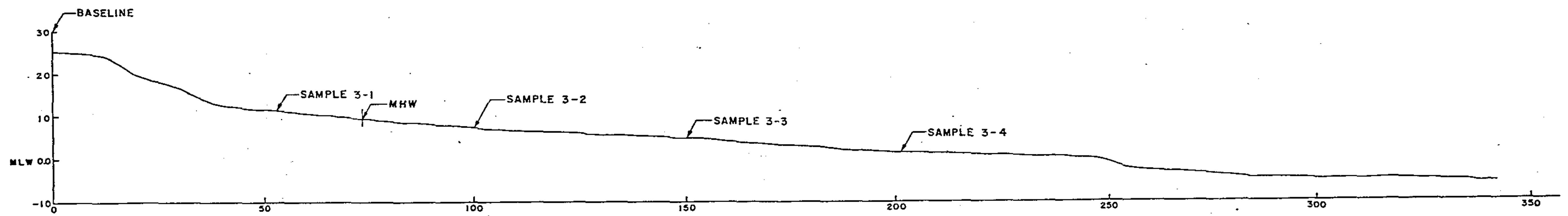
In summary, the existing material at South End Beach reflects two sources, erosion of the gravel and sand glacial till bank at the rear of the beach, and material from adjacent shellfish beds. The material is generally poorly graded running from coarse gravel to fine sand with no noticeable silt content. There is a tendency, as expected, for the material to become finer as you proceed offshore.



PROFILE 1A



PROFILE 1B



PROFILE 2

GRAPHIC SCALES

1" = 10' 10 0 10 20

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WALTHAM, MASS.

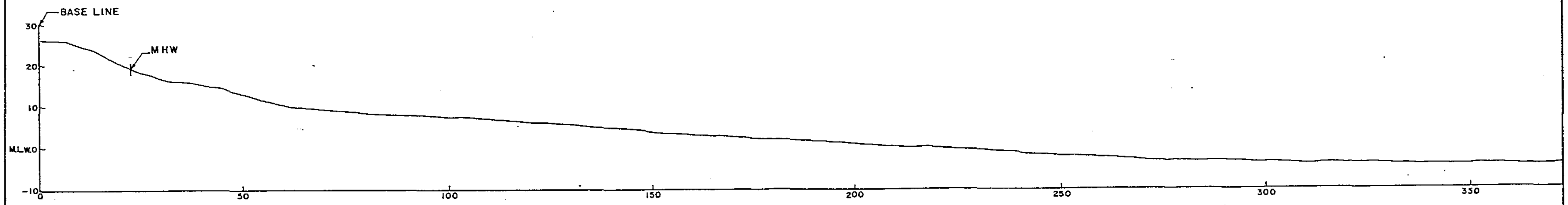
SOUTH END BEACH EROSION STUDY

ROCKLAND, MAINE

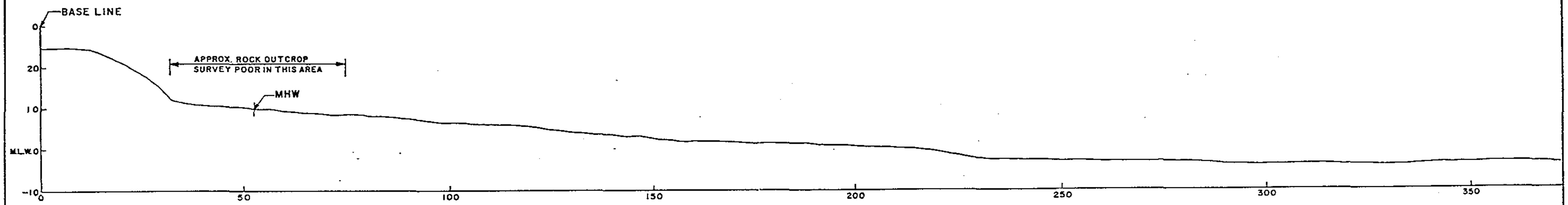
EXISTING BEACH PROFILES

OCTOBER 1985

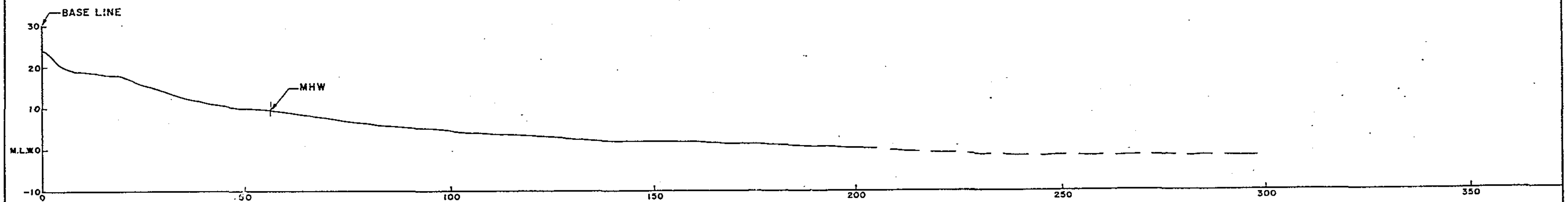
FIGURE 14-A



PROFILE 2A



PROFILE 3



PROFILE 3A

GRAPHIC SCALES

1" = 10' 10 0 10 20

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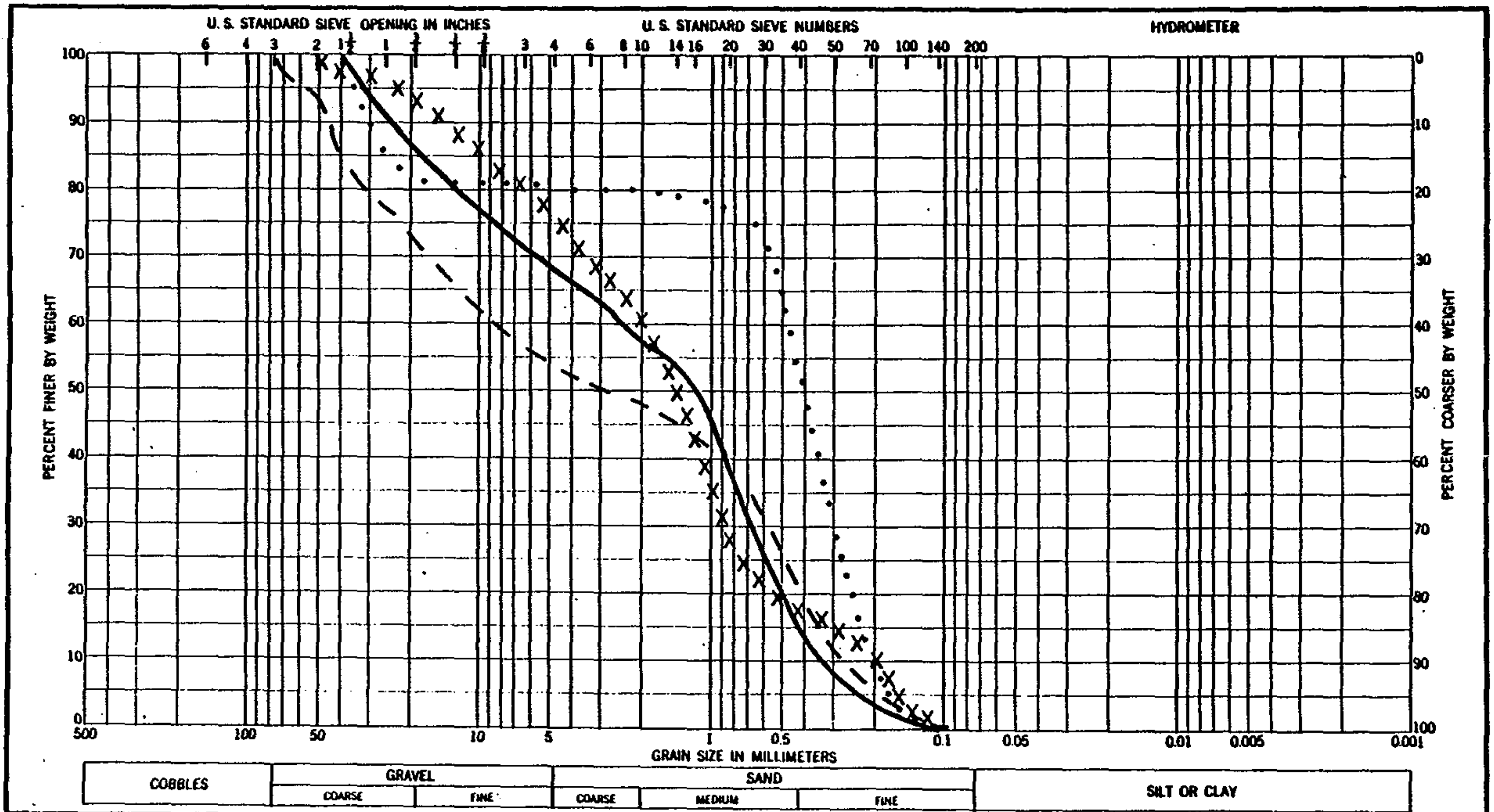
SOUTH END BEACH EROSION STUDY

ROCKLAND, MAINE

EXISTING BEACH PROFILES

OCTOBER 1985

FIGURE 14-B



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3 - 1	SURFACE	• • • • • • • • • • •				
3 - 2	SURFACE	— — — — — — —				
3 - 3	SURFACE	————————				
3 - 4	SURFACE	XXXXXXXXXX				

GRADATION CURVES

Project SOUTH END BEACH EROSION STUDY
Area ROCKLAND, MAINE
Boring No. COMBINED GRAIN SIZE ANALYSES
Date

ENG FORM 1 MAY 63 2087

FIGURE 15

B. ENVIRONMENTAL

1. Marine Ecosystem

The water quality in Rockland Harbor in the vicinity of South End Beach is influenced by both flows into the Penobscot River and Bay, and by local discharges. The level of quality may be approximated by information obtained at Atlantic Point, on a weekly basis, during the period extending from May into September of 1984. Data was provided by the Maine Department of Environmental Protection, Bureau of Water Quality Control, (Maine DEP - BWQC) by personal communication. Nineteen samples were taken. The median total coliform count was 290; 9 out of 19 samples exceeded 330. The median fecal coliform count was 15; 7 out of 19 samples exceeded 70; and 4 samples exceeded 500. A fecal coliform count of 200 or more is considered unacceptably risky for swimming by Maine DEP - BWQC. Water quality in the harbor has significantly improved since 1978, when the local wastewater treatment plant opened in Lermond Cove about 0.8 mile to the northward. A result of this improvement has been the scheduling of a harbor swim event at the annual Rockland Seafood Festival.

A site visit to South End Beach was made on April 4, 1985, to conduct biological sampling at the beach and to quantitatively evaluate the existing beach environment. The detailed data obtained may be found following the Section 404(b)(1) Evaluation, in Appendix 1.

South End Beach provides a typical New England rocky intertidal habitat on the seaward section of its southern portion and also on a smaller area along the beach's northern boundary. The northern portion of South End Beach as well as the landward section of the southern portion provides a sandy beach intertidal habitat. The rocky intertidal seaward section of the southern beach portion had approximate densitites of 1,825 blue mussels (Mytilus edulis) per square meter (mean length=4.41 cm). The northern boundary rocky intertidal area contained approximately 2,300 Mytilus edulis per square meter (mean length=5.15 cm). Both of these densities define highly productive assemblages of mussels and associated organisms. In addition to Mytilus edulis, there was a profusion of barnacles (Balanus sp.), common periwinkles (Littorina littorea), rockweed (Fucus vesicioles) and knotted wrack (Ascophyllum nodosum) on the rocky intertidal areas. The northern portion of the beach and the landward section of the southern beach portion contained an impoverished benthic intertidal sand assemblage. These areas contained only two species of polychaetes. Subtidally, the benthic population at South End Beach is assumed to be productive, based on two cores taken off the northern portion of the beach. No soft clams were found anywhere at South End Beach.

The South End Beach area is utilized by fishermen and the predominant fish caught are Atlantic mackerel (Scomber scombrus) and pollack (Pollachius sp.) (U.S. Fish and Wildlife Service - Personal Communication).

2. Terrestrial Ecosystem

No bird species nest on South End Beach. The beach is not an important resting or feeding place for birds. The adjacent terrestrial habitat at South End Beach is dominated by a railroad track along the backshore embankment, fringed by grasses and shrubs.

3. Threatened and Endangered Species

Except for occasional transient peregrine falcons which may stop briefly, no threatened or endangered species utilize the study area.

4. Archaeological and Historical Resources

As the present beach and backshore have been heavily eroded since the 19th century, no intact terrestrial or underwater archaeological resources would be anticipated within the project impact area.

C. SOCIAL

South End Beach is a city-owned property with backshore frontage along Scott and Ocean Streets to the west and shoreline frontage along the Atlantic Ocean (Penobscot Bay) to the east. The beach is bordered on the north by an embankment of large granite blocks on a property owned by the Holmes Packing Company and on the south by ledge outcrops extending from the backshore to the ocean and containing shells and marine life. Further south is a property owned by the Stinson Packing Company containing a bathing area and an embankment area which presently provides offstreet parking to visitors to the beach.

South End Beach is essentially a municipal beach having the potential for partially satisfying the demand for ocean swimming in the city of Rockland and several nearby communities. South End Beach is unlikely to attract a large number of visitors from towns other than Warren, Thomaston and portions of Owls Head because of the small size of the beach, the availability of ocean swimming at developed beaches in Camden and Lincolnville to the north and at the undeveloped state beach at Birch Point in Owls Head to the southeast, and a freshwater facility at Lake Chickawaukie about 2 miles to the north in Rockland. The study area is therefore comprised of the city of Rockland, and the towns of Warren and Thomaston and a portion of Owls Head. Most of the visitors from the city would travel between 100 yards to about a mile to the beach, although visitors from more remote parts of the city and the study area could travel up to 15 miles.

During the two decades from 1960 to 1980, the population of Knox County, for which Rockland and the three above towns account for nearly half, has grown at approximately the same rate as that of the state of Maine or 16.3 percent. The differential changes within the county reflect the national trend of suburbanization of the population. The four communities in the study area, Rockland, Owls Head, Thomaston and Warren, grew at 5.6 percent between 1960 and 1980. There are no reasons to expect that future population changes in the study area would be different from the historical trend. Population projections for the study area are presented in Table 4, Appendix 5 (see page 5-10).

The income of Rockland residents is lower than that of average income for Maine residents. Median family and household incomes and per capita income for Maine residents in 1979 were respectively, $16,167, $13,816, and $5,768. Inhabitants of the city of Rockland achieved 80, 77, and 93 percent respectively of these income levels. The percent of families with incomes below the poverty level exceeded the state's average by more than 50 percent. The percentage of residents below the poverty level in the neighborhood immediate to South End Beach is more than double the state average.

The civilian labor force in the Rockland Labor Market Area (RLMA), consisting of Knox County plus the town of Waldoboro, has grown at a faster rate in recent years than that of the population. Unemployment for the period 1975 to 1983 has hovered around the state average.

More than one-half of the RLMA's civilian employees are employed within the city of Rockland. In 1980, the number of persons 16 years of age and over seeking employment was 3,307 of which 14.1 percent were unemployed as compared to 8.4 percent in the RLMA. Besides its high rate of unemployment, Rockland's employment is also characterized by its seasonality, particularly in the fish processing industries.

Probably the most significant event affecting South End Beach was the opening of the Rockland Wastewater Treatment Plant which intercepted outfalls that had formerly discharged wastes into the harbor. The beach, which is located between two fish processing plants, has benefited from the progressive cleanup of Rockland Harbor and people have begun to use the beach again. The city now organizes activities at the beach as part of its promotional programs for recreation and tourism. The cleaner harbor has been a factor in increased recreational boating, and the beginning of harborfront development at the north end of the city.

The official opening of the Rockland Wastewater Treatment Plant signaled the beginning of improved water quality in Rockland Harbor and increased recreational boating activity and bathing. It was also the genesis of harborfront residential development. In addition, an Urban Development Action Grant (UDAG) has served to spur a revitalization of downtown Rockland by the creation of additional parking, and the improvement of sidewalks, lighting and the installation of benches. The downtown area is within walking distance of South End Beach.

The Rockland Comprehensive Plan has made the following recommendations with respect to the use of waterfront properties:

* Encourage land use which takes maximum advantage of the natural physical conditions found in Rockland.

* Increase public access to and use of the harbor.

* Encourage use of the waterfront property for water-oriented activities. Use the harbor as a major focus of future tourist-oriented and residential development.

  - Retain and encourage existing commercial and industrial activities which require or benefit from waterfront location to remain on the waterfront while directing the relocation of others to more suitable sites in the city. Several industries formerly based at the waterfront have relocated to the industrial area.

  - Remove underutilized waterfront buildings along Main Street in order to open views of the harbor to residents, vehiculists and pedestrians.

*Recommendations applicable to South End Beach

D. ECONOMIC

1. General

Rockland's economy is derived from its harbor, and its role as the administrative, commercial and industrial center for Knox County and beyond.

Rockland Harbor is one of Maine's largest fishing ports and accounts for about one-third of fish landings in the state. Sardine canning, sea moss extraction and fish meal production are important waterfront activities. Other activities not requiring waterfront location are being encouraged to locate in the city's industrial park. Regular passenger and freight service from Rockland serves island communities in North Haven, Vinalhaven, and Matinicus.

Rockland's industrial economy is composed of a variety of relatively small industries. To the traditional industries, such as ship and boat building and repair and fish processing, have been added in more recent years leathers, apparel, cheese making, metal fabricating and food related industries.

Rockland remains the commercial center of Knox County, including its island towns of Vinalhaven, North Haven and Matinicus. Taxable sales in Rockland in 1982 were $76.9 million as compared to $39.9 million for the town of Camden, 7 miles to the north, its closest commercial rival.

2. Beach Space Supply and Demand

Rockland is located within the area served by the Eastern Mid-Coast Regional Planning Commission, one of the two commissions within the Mid-Coast Planning District. The April 1983 Maine State Comprehensive Outdoor Recreation Plan (SCORP) indicates that capacity for ocean swimming in the Mid-Coast Planning District is sufficient. While capacity may be sufficient for the entire Mid-Coast Planning District, it is insufficient for the eastern sector of the district.

Existing ocean swimming capacity within the Eastern Planning Commission is limited. Of the 15,890 feet of developed public beach frontage in the Mid-Coast Planning District only 775 feet or 5 percent is located within the Eastern Planning Commission.

At present, there are no developed public beaches for ocean swimming within the city of Rockland. The nearest such facilities are two small municipal beaches with a total frontage of 77 feet in Camden some 7 miles north of Rockland. However, the nearest developed public beach of significance is the 500-foot long Lincolnville Beach which is some 15 miles to the north. Communications with local officials indicate that residents of the Rockland area seek ocean swimming at the beaches in Camden, Lincolnville, Birch Point (Owls Head) and at private and public unsupervised areas in the vicinity of Rockland.

Rockland has received state assistance funding and is in the process of establishing a public freshwater beach (550-foot frontage) and facilities on 3.5 acres of land at Chickawaukie Lake on the north side of the city, some 3 miles from South End Beach.

The estimation of demand for beach space in Rockland is hindered by the fact that although some very limited bathing exists at the South End Beach, particularly since the harbor has become cleaner, no attendance figures are available.

The only readily available information pertaining to demand is found in the 1983 Statewide Comprehensive Outdoor Recreation Action Program (SCORP) prepared by the Maine Bureau of Parks and Recreation. Based on a survey of recreation and leisure preferences, 21.2 percent of the people in the Mid-Coast Planning District participate in ocean swimming activities away from their backyards or camps. The average number of participation days is 14.7 per year.

Knox County growth has, however, not been even over the area. It has varied from a decline of 9.7 percent in the city of Rockland to an increase of 64.3 percent for the town of Owls Head. The population in the study area grew at approximately 5.6 percent for the period, and it is assumed that it will continue to grow at its historical rate.

Annual demand is reported as daily demand assuming an 80-day swimming season extending from late June to early September. The 80-day season is reduced by 25 percent to account for inclement weather, resulting in a season of 60 good weather days. Of the 60-day season, 35 are considered average days, while 25 are considered peak days. It is assumed that demand on peak days is double the demand on average days. Peak and average daily demand for ocean swimming in the South End Beach study area in 1985 are 1,138 and 569 visitors, as discussed in Appendix 5.

At present visitors may arrive at the South End Beach on foot, by bicycle or private automobiles (those requiring parking and those dropping off visitors), by taxi or by regular transportation service organized for senior citizens. Occasionally small youth groups may arrive by van. No mass public transportation system of buses or trains serve the beach.

It is estimated that spaces would have to be provided for approximately 140 vehicles after South End Beach is improved. Parking for approximately 100 vehicles would be available on the extended South End Beach property and on a parcel which the city of Rockland partially owns within walking distance on Marine Street. In addition, the city permits parking on all local streets except immediately adjacent to corners. A number of reasonable options are available to the city of Rockland for dealing with the need for vehicular parking spaces. Assurances would need to be received from the city that public parking and access would be provided. Lack of sufficient parking facilities in the general public would preclude eligibility in Federal participation.

E. WITHOUT PROJECT CONDITION

If stabilization of the beach is not undertaken, the erosional process will result in continued loss of city park land and the railroad line, with a general decrease in the recreational value of the beach and increased maintenance costs to the city of Rockland. The city may initiate remedial action without Federal assistance on an as needed basis. However, the city would not be expected to finance a comprehensive solution on their own.

It is estimated that the steep backshore embankment erodes an average of 6 to 12 inches per year over a length of approximately 450 feet, although erosion for any particular year may be more or less than the average. During a 50-year period the top of the embankment would recede about 25 feet. No buildings would be affected.

III. PRELIMINARY PLAN DEVELOPMENT

A. GENERAL ALTERNATIVES

Two general types of management measures exist for addressing the problem at South End Beach: nonstructural and structural.

Nonstructural measures include:

1. Do nothing and allow the beach and backland to continue eroding naturally.

2. Establish guidelines for beach use.

Structural Measures Include:

1. Place suitable sandfill along the beach.

2. Construct groins to compartmentalize the beach to trap littorally transported sand.

3. Construct an offshore breakwater to reduce wave action and erosion therefrom.

4. Place a rock revetment along the eroding backshore slope.

All of the above solutions were studied for their applicability in correcting the primary South End Beach problem of erosion and the opportunity to improve the recreational and aesthetic aspects of South End Beach.

The nonstructural measures were eliminated from consideration as they do not alleviate the problems or enhance the opportunities at South End Beach. The "do nothing" alternative would allow present problems to continue and likely increase, threatening the railroad line and reducing recreational land area.

Guidelines for beach use are generally effective only for environmentally sensitive areas such as barrier beaches, dunes or salt marshes which are not directly adjacent to population concentrations and commercial activity. Such guidelines are not appropriate solutions for the physical and socio-economic environment at South End Beach.

Since nonstructural measures are inadequate to address the problems at South End Beach, structural measures are needed. Before they can be effectively addressed design criteria must be established.

B. DESIGN CRITERIA

1. Physical

In a shore protection project the primary design criteria needed are a tide level and design wave since these will determine where the beach and backland will be attacked.

a. Tidal Flood Level.

Because of the continual variation in water level due to the tides, several reference planes, called tidal datums, have been defined to serve as a reference zero for measuring elevations of both land and water. Tidal datum information for Rockland is presented on Figure 12 and Table 1. These data were compiled using currently available short-term National Ocean Survey (NOS) tidal benchmark data for Rockland along with the CERC report entitled, "Tides and Tidal Datums in the United States," SR No. 7, 1981. The Project Datum for South End Beach is mean low water (MLW) and where possible all elevations are referenced to MLW.

Profiles of major past tidal floods have been developed along the New England coast. NOS tide gage records and high watermark data gathered between gage locations after major storms have been utilized in the development of these profiles. Additionally, profiles of storm tides of selected frequencies have been developed utilizing frequency distributions at tide gages and high watermark information. Based on this information, a tidal flood frequency for South End Beach was estimated (Figure 11).

Using this information a project design tide of +13.9' MLW was selected. This reflects a 5-year return frequency, as selected in Appendix 4 on the basis of economic, environmental and engineering factors, with allowance for continuing sea level rise over the 50-year economic life of the project.

Table 1

Rockland, Maine
Tidal Datum Planes
(From 1960-1978 Tidal Epoch)

	Tide Level (ft. mlw)
Maximum Probable Astronomic High Water	+12.2
Mean Spring High Water (MHWS)	+10.4
Mean High Water (MHW)	+ 9.7
Minimum Probable Astronomic High Water	+ 7.1
Mean Tide Level (MTL)	+ 4.8
National Geodetic Vertical Datum (NGVD)	+ 4.7
Maximum Probable Astronomic Low Water	+ 2.3
Mean Low Water (MLW)	0.0
Mean Spring Low Water (MLWS)	- 0.8
Minimum Probable Astronomic Low Water	- 2.6

b. *Winds and Waves:*

An essential aspect of any coastal engineering project is the selection of a design wave. This wave is the one the project is designed

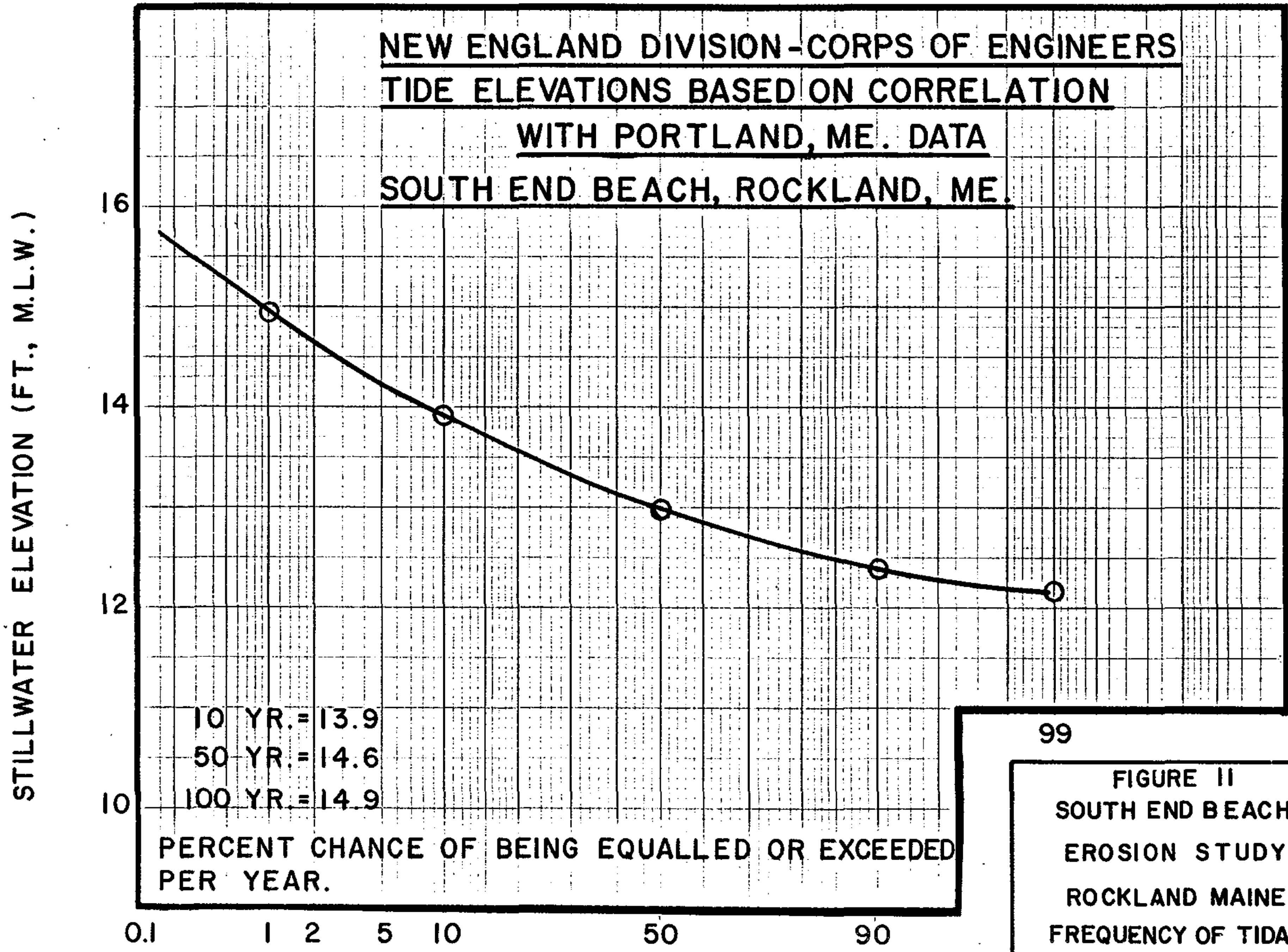


FIGURE 11
SOUTH END BEACH
EROSION STUDY
ROCKLAND MAINE
FREQUENCY OF TIDAL
FLOODING AT ROCKLAND

TIDAL DATUM PLANES

ROCKLAND, MAINE

(BASED UPON CURRENTLY AVAILABLE, SHORT TERM, NATIONAL OCEAN SURVEY TIDAL BENCHMARK DATA FROM 1960-78 TIDAL EPOCH)

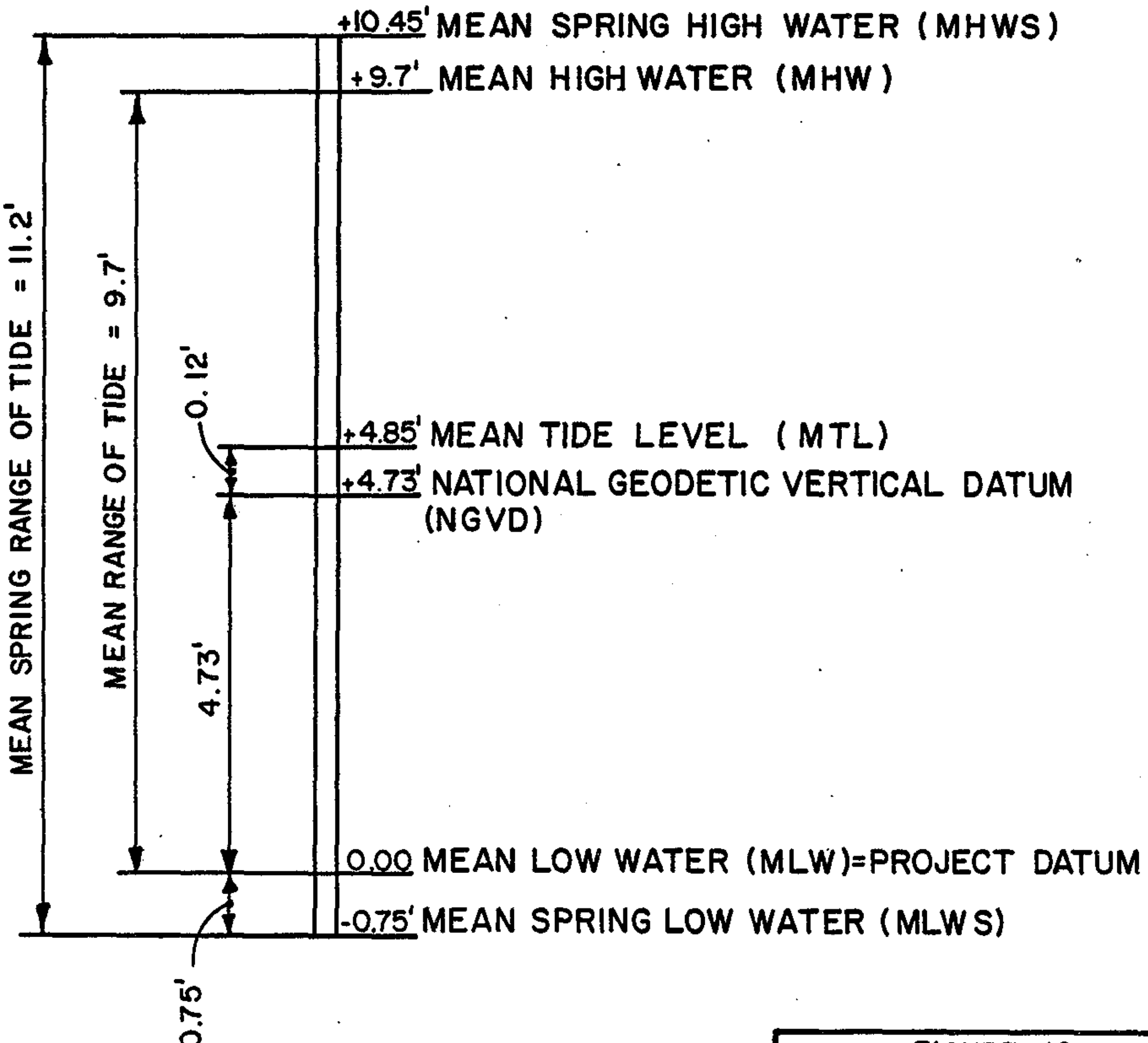


FIGURE 12
SOUTH END BEACH
EROSION STUDY
ROCKLAND MAINE
TIDAL DATUM PLANES AT ROCKLAND

to withstand without damage. Progressively larger storms and waves will cause progressively greater damage to the structure. In the case of South End Beach the return period selected for beach fill analysis was 5 years, the same as the return period for the design water level (See Appendix 4.)

A determination of wind velocity is the next required information for determining a design wave.

Utilizing the wind data supplied in Appendix 2, average windspeeds and resultant directions were computed over various durations. Annual maximum values were then determined for each onshore direction. The frequency of these annual values has been determined. Figure 13 depicts the windspeed-duration relationships for the event with a 5-year recurrence interval, which is based on data from Table 2.

Table 2

Summary of Wind Velocity, and Duration for Various Expected Return Periods For Easterly Winds

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100
1 min	21	36	44	49	56	61	67
1	17	29	36	40	45	49	53
2	14	26	33	38	43	47	51
3	14	24	31	36	43	48	53
4	12	23	29	32	37	40	43
6	10	21	26	30	33	36	39
8	12	21	27	31	36	40	44
12	5	17	22	25	28	31	33

The presence of Rockland Breakwater is significant, since without it South End Beach would be exposed to a much larger fetch to the northeast. Waves from this direction could be larger than those from the east without the breakwater. As waves pass a structure there is a modification of the wave pattern and height into the lee of the structure which is called refraction. This situation was investigated for South End Beach. Waves from the northeast incident on the beach are reduced to approximately one third of their original height. Therefore, no wave from the northeast can be larger than design wave from the east. A similar condition applies for wave from the south- southeast where Owls Head forms a natural breakwater in that direction.

There is a minor, secondary fetch within the harbor itself of approximately 1.5 miles to the northeast. No wave comparable to the design wave can be generated over this relatively short stretch of shallow water however.

Annual recreation benefits are determined by subtracting the recreational value under the without-project condition from recreational value with the project. Recreational values are measured in terms of users' willingness to pay for the use of the facilities. The Unit Day Value (UDV) Method is appropriate here since the beach would service general recreation needs for less than 750,000 annual visits at a cost of less than $1,000,000.

Under the "with plan conditions," improvements would be made increasing the capacity of South End Beach (by extending the public beach further south and by raising and widening the dry beach area) and insuring its maintenance and aesthetic appeal. Visitors would use the beach for ocean swimming, sunbathing and picnicking (particularly for those employed or living in the area), and for those seeking views of the harbor. In addition, Plan 1 (50-foot-wide beach with south groin) and Plan 2 (50-foot-wide beach with two groins) would protect the intertidal area to the south of the beach to permit viewing and handling of marine life by visitors. The groins which would be constructed as part of these two plans could also offer fishing opportunities for a limited number of visitors. For those reasons, Plans 1 and 2 would provide slightly higher value visits than Plan 3 (50-foot-wide beach with no groins). Table 3 summarizes the recreational values, as evaluated in Appendix 5, for the without-plan condition and for the three plans.

Table 3

South End Beach, Rockland, ME
Beach Recreation Points for Visitors in Study Area

	Without Plan	Plan 1	Plan 2	Plan 3
a. Recreation Experience	2	12	13	10
b. Availability of Opportunity	3	3	3	3
c. Carrying Capacity	1	8	8	8
d. Accessibility	15	15	15	15
e. Environmental quality	4	11	11	9
TOTALS	25	49	50	45

The recreational benefits of beach improvement are simply the differences between the annualized recreational values with each plan and these values without the plans. Recreational benefits and economic justification for the various plans are summarized in Table 4, as calculated in Appendix 5.

Based on engineering, economic and environmental factors and shown more fully in Appendix 2 and Appendix 4, it was calculated that the maximum wave capable of attacking South End Beach with a 5-year return frequency was 4.4 feet in height with a period of 4.2 seconds generated by a 33-mph wind from the east with a duration of 2 hours. On either side of this wind value, waves would be smaller due to fetch or duration limitations. The wave selected above would break in a water depth of approximately 5.6 feet, which at many stages of the tide would be well up the beach face.

2. Environmental

South End Beach is partially divided into two areas by large rock outcrops extending from the backshore to approximately mean low water. The beach provides a typical rocky intertidal habitat common to the Maine coast on the seaward section of its southern portion and also at the beach's northern boundary. The northern portion of South End Beach and the landward section of the southern portion provide a gravel and medium-to-coarse sand substrate.

The rocky intertidal sections are highly productive, and are inhabited by considerable communities of Blue Mussels (Mytilus edulis) and associated organisms. The sandy parts of the beach comprise an impoverished sand assemblage of biota, primarily of the polychaete Capitella capitata.

The criteria for the project with respect to environmental conditions are to minimize impacts on the productive rocky intertidal habitat at South End Beach and provide the ability of the project to perform its primary functions of shore protection and provision of recreation beach space within the constraints of economic practicability.

3. Social

The primary social impacts of South End Beach and adjacent park are its value to the local community as a buffer between the ocean and the community and the recreational benefits it provides to the neighborhood and surrounding communities.

The project criteria with respect to social aspects is to maintain the shore protection function of South End Beach so as to minimize loss of public park land and enhance the recreational capacity at the beach.

4. Economic

The economic criteria for the project, as previously described, are to satisfy National Economic Development (NED) while considering environmental quality and other social effects. To qualify for Federal participation, a recommended plan must not only be economically justified (benefits must outweigh costs) but must maximize net economic return consistent with protection of the environment. This is the NED plan.

C. PRELIMINARY ALTERNATIVE PLANS.

1. Protective Beach

Beaches dissipate wave energy and provide protection to adjacent backlands. South End Beach currently provides such protection at less than spring tide (semimonthly highest range of tides) and storm wave conditions. During high-water and storm-wave conditions the beach is largely ineffective, and the backland is attacked and eroded. It is therefore a logical concept to consider widening the existing beach to provide additional protection from higher tides and waves than it can presently resist. This plan would involve placing suitable sandfill to an elevation and slope to provide protection from tides and waves having a 5-year expected return period.

Based upon previously developed data for wave and tides, it was determined that a maximum final berm elevation for a protective beach should be at +15' above mean low water. The slope of the beach should not be flatter than the existing beach slope, which is 1 vertical to 15 horizontal. The slope could, depending on fill material selected, be steeper. Fill material used on the beach should be no finer than the existing material and in general should be somewhat more coarse to minimize losses of finer material and reduce the need for periodic renourishment.

It must be recognized that a beach is an accumulation of unconsolidated material in a dynamic environment which is hostile to its existence. A protective beach is usually designed for a relatively short return period (in the interest of avoiding unduely high project costs) and will sometime during the project life be attacked by larger waves at levels significantly higher than designed. In addition, relatively small scale losses and redistribution of the sand will result from man's use of the beach. It is necessary that there be some reserve capacity in the protective beach such that it can endure these periodic losses and still provide protection until it is restored naturally or artificially. In a natural beach this is provided by the berm and dunes behind it. At South End Beach there are no dunes, and the berm alone must absorb the impact of wave erosion. It follows that the wider the berm, the greater the protection and recreational benefit in terms of useable beach space. The negative aspects of the wider berm are increased costs, initially and for future maintenance, and greater environmental impact since the fill would extend further into the biologically productive subtidal area. In reviewing the protective beach, alternative berm widths of 25, 50 and 75 feet were investigated. The 50-foot width was selected as most applicable to the existing conditions and conformable with the design criteria. The 25-foot width was considered inadequate to provide the reserve protection needed for the backland and inadequate dry beach area for recreational needs. The 75-foot width was rejected because it would intrude further into the subtidal area and the additional dry beach space provided would be greater than needed.

The length of the protective beach required may also vary depending on the characteristics of the study area. The portion of the beach between the two southern outcrops has a sandy upper portion with a rocky productive intertidal area. The outcrop forming the southern boundary is also a very productive area. Sand placed the entire length of the project area would cover the productive rocky intertidal area on the southern beach portion eliminating that habitat. It could also impact the outcrop and biological community to the south. There exists the option of eliminating this potential impact by placing a groin along the outcrop to limit the main beach fill from filling the rocky intertidal zone to the south. Dry beach area could still be developed in this southern portion by using coarser sand with a correspondingly steeper slope to avoid the intertidal area.

2. <u>Groins</u>

Groins are typically used to interfere with littoral transport close to shore causing deposition of sand and subsequent widening of the beach. As previously noted the exposure and topography at South End Beach indicates sand movement is primarily on and offshore rather than parallel to it. A south groin could prevent sandfill from adversely impacting the intertidal rocky habitat and a north groin may or may not be useful in eliminating sand loss from beach fill.

The concern at the northern end of the beach would be potential sand loss. Loss of sand along the shore to the north could be eliminated by a groin at this end of the beach. However, as previously noted, the direction of wave approach and the shore configuration indicate most sediment movement would be onshore and offshore. The need for a groin at the north end of the beach is problematical and could best be considered after observing the fate of any fill placed on the beach.

3. <u>Breakwater</u>

A breakwater is a structure placed so as to interrupt the movement of waves onto shore. It may be connected to the shore or lie completely offshore. The functional portion is usually parallel to the shore it is to protect. At South End Beach a breakwater capable of protecting the shoreline and minimizing erosion is possible. It would, however, provide no improvement in the recreational capacity of the beach and would interfere to some extent with the view from the beach and park. It would also be relatively more difficult to construct and maintain since the breakwater would be offshore. Because of the failure of the breakwater to enhance the recreational aspects of the beach, it has been eliminated from further considerations.

4. <u>Revetment</u>

A revetment is a protective structure placed directly on the land to be protected. Typically it takes the form of armor units laid on a slope leading to the backland. It should have a nonerodable surface. Revetments, in a fashion similar to seawalls, often have the effect of protecting the backland but accelerating erosion in front of them by deflecting wave energy to the toe.

A revetment could be designed which would eliminate erosion of backland at South End Beach at a reasonable cost. It would however have a negative effect on the existing beach and possibly eliminate much of the present recreational capacity of the beach. While a revetment along the entire backshore area has been eliminated as a solution for South End Beach, resetting of existing riprap on a filter fabric and crushed stone base would protect the eroded backshore at the north end of the beach.

D. PRELIMINARY PLAN EVALUATION AND COMPARISON

The preceding sections have eliminated a breakwater and a new revetment from further consideration because they would not maximize development of the resources in the study area. Groins alone would not satisfy the shore protection and recreational needs but could have application in connection with a protective beach.

Therefore it was determined that a protective beach, with or without groins, having a berm width of approximately 50 feet would best resolve the problems at South End Beach. This solution is developed in detail in the following sections.

IV. DETAILED PLAN FORMULATION AND IMPACT ANALYSIS

A. DETAILED ALTERNATIVE PLANS

1. Plan 1: Protective Beach - South Groin

As previously noted there is a biologically productive intertidal and subtidal habitat at the southern end of the beach which continues to the rocky area south of the project. This habitat is a source of food and beach material which should be preserved. This alternative is intended to provide the necessary erosion protection and recreational benefits while minimizing impact on this resource.

The beach would be divided by a groin into a northern and southern portion (see Fig. 16). The northern portion would have sand appropriately sized to form a slope no less steep than the present slope of approximately 1 vertical to 15 horizontal (1V:15H). The groin would be located along the south edge of the sandfill and oriented to make maximum use of the rock outcrop to minimize stone quantities and environmental impact. It would retard the small potential for littoral movement of sand material to the south generated by in harbor waves from the northeast. The primary effect of this groin would be environmental protection by compartmentalizing the beach into a northern primary bathing area and a southern section. That area of the southern portion above the rocky intertidal section. That area of the southern portion above the rocky intertidal area would have the dry beach area filled with a coarser grade of sand. This would allow dry recreational use but with a steeper slope to minimize encroachment on the intertidal zone. The slope on the south portion of the beach would be approximately 1V:7H by using a much coarser fill.

The groin itself would be of native stone and have a habitat value similar to the existing outcrops. The surface area useable as habitat would be greater than for a comparable area of outcrop and in time it is anticipated the blue mussel community could even increase over the present numbers.

The groin would have a top slope similar to the minimum north beach slope 1V:15H and a top elevation 1 foot higher than the north beach profile to ensure its effectiveness in preventing sand movement to the south. It would terminate at a depth of approximately 3 feet below MLW.

The proposed cross section and profile is shown in Figure 16. Side slopes would be 1V:1.5H with the nose sloping 1V:2H. The crest width would be 4 feet and armor stone would weigh from 2,000 - 3,000 pounds apiece. The armor stone is sized for a 50-year storm event since this would not result in an unreasonable size stone to handle and would minimize groin maintenance over the project life. Between the armor stone and core stone a transition layer of stone from 150 to 300 pounds would minimize loss of the finer core material. The groin, 180 feet long, would require approximately 2,240 tons of stone.

The coarse sand base has more than adequate bearing capacity to support the groin but long-term settlement would be likely as the finer base material worked up into the 3- to 6-inch core stone of the groin. This settlement could be eliminated or minimized by placing the groin on filter fabric which would maintain separation of the two materials and prevent intermixing. It would also minimize shifting of material due to scour during and after construction. It is estimated that a 450-foot length of protective beach would provide a dry beach area above MHW of approximately 68,500 square feet. This would require the initial placement of a total sand volume of 27,000 cubic yards. Periodic nourishment of approximately 5,000 cubic yards of sand would be required every 10 years or so.

Consideration should be given to utilizing the rocky intertidal habitat as an outdoor display/classroom by providing displays in the park area with descriptions of what is present in that area. A description of the local geology and historical past of shipyards and limekilns in the immediate area could also enhance the recreational potential at small cost.

As part of all three detailed alternative plans (see figures 16-18 at end of "RECOMMENDATIONS" section), the jagged, relatively ineffective stone revetment along the northern boundary of the beach would be corrected. Random placement of the large, sharply angular blocks make this a safety hazard. Poor stone placement and lack of a base has allowed erosion behind it. These blocks should be removed and stockpiled. The slope may then be roughly graded and a base of stone placed on filter fabric supplied. The stockpiled stone could then be placed in a coherent manner which would have some erosion protection benefit.

2. Plan 2: Protective Beach - North and South Groins

This alternative is similar to that of Plan 1 with the addition of a terminal groin at the north end. It has been previously noted, due to the limited maximum exposure to the east, that sand movement is primarily onshore and offshore rather than alongshore. In-harbor waves come primarily from the northeast and the minor amount of sand movement from these small waves would be southward. There is some possibility, considered small, that the sandfill could migrate along the northern slope due to wave attack. The presence of the existing revetment and slope erosion behind it indicate that this historically has been a primary erosion area. To eliminate or minimize this problem a groin would be placed to restrict sand movement to the north and by its orientation protect this section of the beach. This groin, as shown in Figure 17, would extend from the rehabilitated riprap slope at a constant 1V:15H slope at the same proposed elevation as the beach fill. It would have a similar configuration to the south groin and be 165 feet in length.

This plan would require approximately 25,600 cubic yards of sandfill, 4,710 tons of rock and provide approximately 62,100 square feet of dry beach for a length equal to Plan 1. Periodic nourishment of approximately 3,000 cubic yards of sand would be required every 10 years or so.

3. Plan 3: Protective Beach - No groins

In this concept there would be no groins and no coarser fill at the south end. (See figure 18). The proposed minimum beach slope would be 1V:15H for the entire beach length. This would mean that much of the rocky intertidal habitat at the south end would be covered. Sediment movement would be primarily onshore and offshore. However, with the absence of a south groin and the in-harbor fetch to the northeast, some sand movement south to the rock area is possible.

Plan 3 would require approximately 38,100 cubic yards of sand and 100 tons of rock for reconstruction of the existing riprap slope at the north end of the beach. The proposed sandfill would provide a dry beach area of 74,600 square feet. Periodic nourishment of approximately 15,000 cubic yards of sand would be required every 10 years or so.

B. *ECONOMIC ANALYSIS*

1. Methodology

The economic analysis is accomplished by first determining the economic justification of each of the proposed plans by comparing the average annual national economic development (NED) benefits expected to accrue to the project compared to the average annual costs of the project over its evaluated economic life (50 years). Benefits and costs are made comparable by conversion to an equivalent annual basis using an appropriate interest rate. All dollar values are expressed in October 1985 prices. For the Federal Government to participate in a project, annual benefits should equal or exceed annual costs.

Secondly, net benefits (annual benefits minus annual costs) are calculated for each project option in order to determine the option that maximizes net benefits.

In principle, the evaluation of shore protection benefits may include tangible primary benefits in the following categories:

- prevention of physical damage to land and structures,

- avoided emergency and business costs,

- enhancement of property values, fish and wildlife resources, and

- increased recreational use.

2. Benefit Analysis

In the case of South End Beach, benefits from the prevention of damage to land and increased recreational use are significant.

In the absence of a plan to improve South End Beach, the present erosion process will continue to result in a loss of city park land, a spur railroad line extending northward from Atlantic Point, and the property at the south end of the beach currently owned by the Stinson Packing Company. The implementation of any of the beach improvement plans including a 50-foot wide sandfill berm at +15 feet MLW would dissipate wave energy and provide protection to adjacent backlands. This protective beach would virtually arrest but not eliminate erosion during the evaluated life of the proposed improvement.

Benefits derived from the prevention of loss of land are computed as the market value of the average area expected to be lost annually in the absence of a plan. A 6-inch loss of land translates into 0.00516 acres valued at $50,000 per acre or about $300 per year. Since each of the three plans under consideration would provide approximately the same degree of shore protection, each would have annual shore protection benefits of $300.

Annual recreation benefits are determined by subtracting the recreational value under the without-project condition from recreational value with the project. Recreational values are measured in terms of users' willingness to pay for the use of the facilities. The Unit Day Value (UDV) Method is appropriate here since the beach would service general recreation needs for less than 750,000 annual visits at a cost of less than $1,000,000.

Under the "with plan conditions," improvements would be made increasing the capacity of South End Beach (by extending the public beach further south and by raising and widening the dry beach area) and insuring its maintenance and aesthetic appeal. Visitors would use the beach for ocean swimming, sunbathing and picnicking (particularly for those employed or living in the area), and for those seeking views of the harbor. In addition, Plan 1 (50-foot-wide beach with south groin) and Plan 2 (50-foot-wide beach with two groins) would protect the intertidal area to the south of the beach to permit viewing and handling of marine life by visitors. The groins which would be constructed as part of these two plans could also offer fishing opportunities for a limited number of visitors. For those reasons, Plans 1 and 2 would provide slightly higher value visits than Plan 3 (50-foot-wide beach with no groins). Table 3 summarizes the recreational values, as evaluated in Appendix 5, for the without-plan condition and for the three plans.

Table 3

South End Beach, Rockland, ME
Beach Recreation Points for Visitors in Study Area

	Without Plan	Plan 1	Plan 2	Plan 3
a. Recreation Experience	2	12	13	10
b. Availability of Opportunity	3	3	3	3
c. Carrying Capacity	1	8	8	8
d. Accessibility	15	15	15	15
e. Environmental quality	4	11	11	9
TOTALS	25	49	50	45

The recreational benefits of beach improvement are simply the differences between the annualized recreational values with each plan and these values without the plans. Recreational benefits and economic justification for the various plans are summarized in Table 4, as calculated in Appendix 5.

Table 4

South End Beach, Rockland, Me
Economic Evaluation

	Plan 1	Plan 2	Plan 3
Annual Benefits			
Prevention of Land Loss	$300	$300	$300
Recreation	117,000	116,900	106,800
Total	117,300	117,200	107,100
Annual Costs	41,500	45,100	52,500
Benefit Cost Ratios	2.8	2.6	2.0
Net Annual Benefits	75,800	72,100	54,600

C. IMPACT ANALYSIS

1. Physical

Plan 1 would provide a protective beach with a 50-foot final berm width and a face slope of 1V:15H or steeper on the north side and 1V:7H on the south side of a rubble mound groin. Perceived impacts are:

a. Approximately 27,000 cubic yards of sandfill and 2,250 tons of stone would require an estimated 3000 truck trips on streets adjacent to the beach during an estimated 3-month construction period. There would be an increase in noise and dust associated with this traffic.

b. There would be a transient, relatively minor and localized increase in turbidity as sandfill and rock are placed. This could be reduced by construction procedures discussed later in this report. The degree of impact would be similar for each concept discussed.

c. Erosion of the backland would be eliminated except in very severe storms. It would be eliminated for weaker storms (those with a return period of 5 years or less) and significantly reduced for more powerful storms. This is similar for each concept.

d. It is likely that with a coarser sand material the beach face would be steeper than the design slope of 1V:15H. This is similar for each concept.

e. The high and low water lines would shift seaward. This is similar for each concept.

f. The groin would interrupt the minimal amount of littoral transport on the beach and provide improved protection for the southern intertidal habitat for in-harbor waves from the northeast.

2. Environmental

a. Plan 1 would entail placing sandfill along 450 feet of usable beach, with the northern and southern portions being separated by a groin, and with the sandfill width substantially limited on the southern beach portion, plus correction of the stone revetment at the northern boundary of the beach, would cover a total of approximately 2.5 acres in area.

(1) Marine Ecosystem. There would be minimal impact on the approximately 1.5 acres of mostly impoverished benthic intertidal community buried on the north beach portion. About 0.5 acre of productive subtidal community and habitat would be buried and permanently lost. Colonization by intertidal organisms on the newly developed sandy intertidal habitat would likely be at least as productive as that on the presently existing sandy intertidal zone there.

On the southern portion of the beach, the sandfill would end at about 140 feet from the backshore embankment, burying only a half acre of relatively unproductive sandy intertidal community. There would be essentially no encroachment by the sandfill upon the desirable intertidal habitat of this beach portion.

Construction of the groin between the two beach portions would necessitate burial of about 3,700 square feet of existing sandy and rocky intertidal habitat and organisms and 2,600 square feet of subtidal habitat and organisms. Little would be lost from the already impoverished sandy intertidal habitat. The subtidal habitat and organisms would be permanently buried and lost. Rocky habitat organisms would likely recolonize the groin, but would probably not fully compensate for losses from natural rocky intertidal habitat. The long-term impact of the groin would be positive, as it would serve to separate and protect the natural rocky intertidal community on the southern beach portion.

Correction of the revetment by replacement of stones at the northern border of South End Beach would result in minimal impacts.

Finally, not placing sandfill on seaward rocky section of the southern intertidal area, and isolating the northern beach portion's sandfill from it with a groin, is a positive aspect of the proposed plan. It would allow the continued existence of a productive biological community. This area would continue to be available to those who wish to enjoy the shoreline in its natural state, and the opportunity would exist for enhancing its value with the provision of interpretive displays located in the backshore park.

Renourishment of approximately 5000 cubic yards of sand above mean high water every 10 or so years for Plan 1 should not significantly affect the local marine ecosystem.

No significant impact on the water quality would be anticipated as a result of the project work; minor and short-term turbidity increases nearshore would be possible during construction. No water quality impacts would be expected to result from periodic renourishment.

(2) Terrestrial ecosystem. No short- or long-term effects on terrestrial resources would be anticipated as a result of project implementation.

(3) Threatened and endangered species. No threatened or endangered species would be impacted by the proposed action.

(4) Archaeological and historical resources. As the present beach and backshore have been heavily eroded since the 19th century, no intact terrestrial or underwater archaeological resources would be anticipated within the project impact area. For this reason, we would expect the proposed action to have no effect upon significant historic or archaeological resources.

(5) Construction Impacts. Construction activities at South End Beach would result in increased noise and dust levels, both at the site and along transportation routes for the trucking of sandfill and stones. However, proper scheduling of the construction activities, to be completed in approximately 3 months, should avoid the peak tourist season traffic. Construction-related effects (noise, dust, traffic, beach and park use) would also be expected during periodic renourishment.

(6) Secondary and Cumulative Impacts. With project implementation, traffic in the vicinity of the beach and park and on access routes to it would increase, having some negative effect on the immediate neighborhood. Large crowds could degrade the beach and park use experience. Limiting use to some capacity number of people at one time could ameliorate these potential effects.

b. Plan 2. About 5 percent less sandfill, but approximately twice as much stone, would be used for Plan 2 as compared with Plan 1. This would result in a net increase of about 250 truck trips. Otherwise there is little significant difference between the two.

c. Plan 3. This concept would bury a productive biological community on the rocky seaward section of the southern intertidal zone and would eventually yield a relatively unproductive sand assemblage. About 40 percent more sandfill would be required than in Plan 1, leading to an additional net increase of 700 truck trips.

3. Socio-Economic

A range of short- and long-term impacts would accrue to residents of the South End Beach study area as a result of implementing one of the alternative beach improvement plans. The socio-economic impact assessment applies generally to all of the alternatives.

a. Short-Term Impacts

The short-term impacts of improving South End Beach would primarily be site-specific and negative during the 3-month construction period. These impacts include a temporary increase in air, noise, and water pollution at the construction site, along haul routes and sand quarrying sites and the disruption of traffic between the source of the sand and the beach. The construction would also interfere with the use of the beach by potential visitors.

b. Long-Term Impacts

The project would require adequate budget and personnel on the part of the city of Rockland. The city has assured that the parking area and beach would be properly maintained so that the socio-economic benefits which are intrinsic to this project would be fully realized. The 1,000 to 1,100 people that this project would draw on a peak summer day would increase pedestrian and vehicular traffic in the immediate neighborhood. The area immediate to the beach would increase in economic value to the extent to which the city effectively manages the area and addresses and solves potential problems created by traffic and the congregation of more people in the neighborhood.

The implementation of any one of the alternative plans would have the long-term effect of impeding beach erosion and of providing ocean bathing for about 3,000 residents of the study area who, on the average, seek approximately 15 days of ocean bathing each per year. The improved beach would serve as a complement to the city's spirited recreational program and to its downtown revitalization project which affects areas within walking distance of South End Beach.

Besides ocean bathing, South End Beach would provide opportunities for sunbathing, views of the harbor, fishing from groins (as in the case of Plans 1 and 2), and the observation and handling of marine life in the intertidal rock outcrop towards the south end of the beach. This latter area also lends itself to an educational interpretive program for visitors which could be undertaken by the city.

Assuming an improved South End Beach and its adjoining neighborhood, the socio-economic impacts of implementing any of the proposed alternatives for beach improvement leads to the conclusion that while some negative impacts, generally of a short-term and site-specific nature, would occur, the long-term impacts would be overwhelmingly positive.

However, Plan 3, the beach sandfill without the most southerly protective groin, would carry the long-term possibility of causing sand to cover the intertidal area on the south side of the beach, thereby impacting negatively on the marine life and limiting if not eliminating, educational and recreational opportunities for visitors.

V. PLAN SELECTION

The plans discussed in the previous section (see figures at end of this section) are compared in Table 5, which appears following the 'Recommended Plan' section.

Based on this comparison and all the previously discussed items Plan 1, a protective beach with a south groin to protect the intertidal habitat at the south end of the beach, was selected for implementation. The reasons follow:

1. The plan provides the maximum net benefits, estimated at $75,800 per year, as compared to $72,100 for Plan 2 and $54,600 for Plan 3.

2. The plan minimizes negative environmental impacts to the productive south rocky intertidal habitat. Plan 3 would not protect the intertidal habitat at the south end of the beach, while Plan 2 would do so at a greater cost.

3. The plan eliminates erosion and land losses at the least cost.

VI. IMPLEMENTATION RESPONSIBILITIES

The Federal Government would be responsible, within a $1,000,000 cost limitation, for 50 percent of the first cost of construction including preparation of plans and specifications, and 50 percent of the future periodic nourishment as required. If these costs exceed the $1,000,000 limitation, local interests must assume all remaining costs. Groin structure and rock revetment maintenance are non-Federal responsibilities. Local cooperation requirements are listed in the "Recommendations" Section at the end of the main report.

VII. RECOMMENDED PLAN

The recommended plan of improvement for South End Beach, Plan 1, entails beach widening by the direct placement of a suitable sandfill (27,000 cubic yards) along approximately 450 feet of shorefront and providing for a 50-foot-wide, level-beach berm at an elevation 15 feet above mean low water for a total sandfill width of 140 feet. Also included is the construction of a 180-foot-long rock groin structure at the south end of the beach and riprap repair along the enbankment at the north end of the beach (for a total of 2,250 tons of rock). The plan would provide the needed backshore protection and restore the protective beach space. A beach monitoring program for a 5-year period in order to evaluate the newly constructed beach would be beneficial.

Table 5

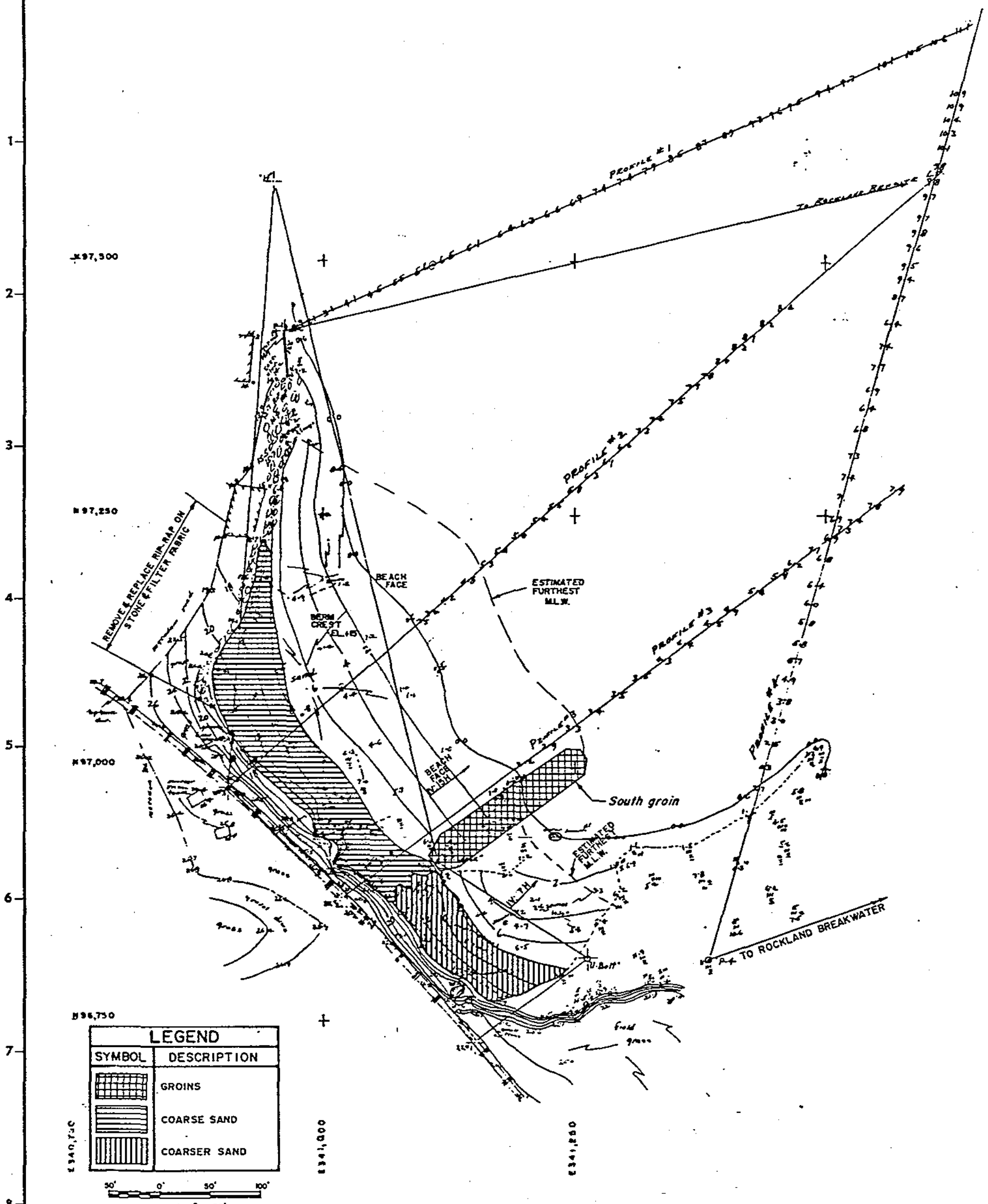
Summary And Comparison Of Alternatives

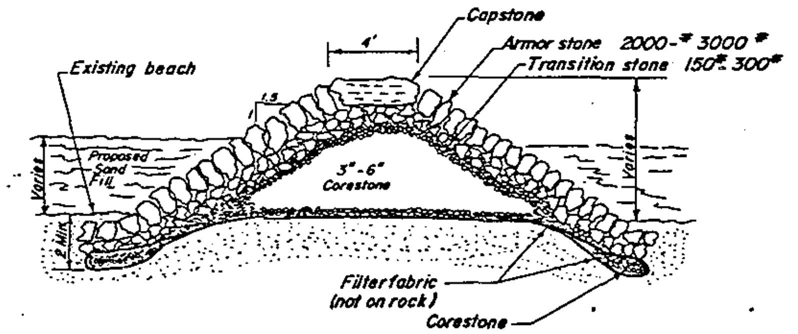
ITEM	WITHOUT PROJECT	PLAN 1 PROTECT BEACH SOUTH GROIN	PLAN 2 PROTECT BEACH N. & S. GROIN	PLAN 3 PROTECT BEACH NO GROINS
1. Beach Berm Width	0 ft.	50 ft.	50 ft.	50 ft.
2. Beach Width Above MHW	0-10 ft.	150'±	150'±	150'±
3. Volume of Fill	0	27,000 c.y.	25,600 c.y.	38,100 c.y.
4. Groins Required	0	1	2	0
5. Amount of Stone Required *	0	2,250 Tons	4,700 Tons	100
6. Estimated Annual Replenishment	0	2%	1%	4%
7. Estimated Total First Cost	0	$400,000	$438,000	$446,000
a. Federal Share 50%	0	$200,000	$219,000	$223,000
b. Local Share 50%	0	$200,000	$219,000	$223,000
8. Estimated Total Annual Cost	0	$41,500	$45,100	$52,500
a. Federal	0	$19,750	$20,550	$26,250
b. Local	0	$21,750	$24,550	$26,250
9. Benefit/Cost Ratio		2.8	2.6	2.0
10. Annual Net Benefits		$75,800	$72,100	$54,600
11. Estimated Rate of Backland Erosion	6"/Year	0**	0**	0**

* All plans would entail resetting existing riprap at north end of beach.
** With periodic nourishment.

Table 5 (Continued)
Summary And Comparison Of Alternatives

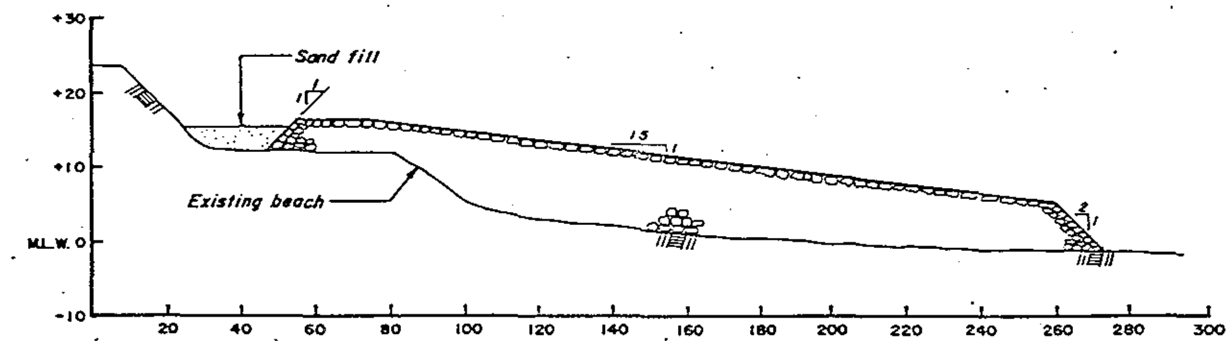
ITEM	WITHOUT PROJECT	PLAN 1 PROTECT BEACH SOUTH GROIN	PLAN 2 PROTECT BEACH N. & S. GROIN	PLAN 3 PROTECT BEACH NO GROINS
12. Environmental Impacts				
a. Water Quality	No Change	Minor transient turbidity during construction. No long-term impacts.		
b. Substrate Impacts	No Change	Loss of half acre of productive subtidal community due to fill. Southern rocky intertidal habitat is protected. Groins will provide additional rock habitat.		Loss of half acre of productive subtidal community plus loss of the productive rocky intertidal commu-ity on the southern beach portion.
c. Air Quality	No Change	Some minor increase in airborne particulate matter during construction. No long-term impact.		
d. Noise	No Change	Temporary increase during construction hours. No long-term impact.		
13. Social Impacts				
a. Park Land	Park land will continue to be lost.	Loss of park land would be eliminated.		
b. Traffic	No Change	Increase in traffic, foot and auto, to and from the beach. Truck traffic would be heavy but temporary during construction.		
c. Parking	Parking at park and adjacent streets.	There would be an increase in parking demand which would need to be met by additional city parking facilities.		
d. Recreation	Progressive loss of existing limited beach area, 0-10' wide at MHW.	. Significant increase in usable beach area with a maximum capacity of 1,141 people. . Provides ocean bathing access for low income residents without own transportation. . Potential reduction in crime rate with increased recreational opportunity.		





TYPICAL GROIN SECTION

NOT ON SCALE



SOUTH GROIN PROFILE

SCALE: HORIZ. 1" = 20' VERT. 1" = 10'

FOR GENERAL NOTES SEE FIGURE 3

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

SOUTH END BEACH EROSION STUDY

ROCKLAND, MAINE

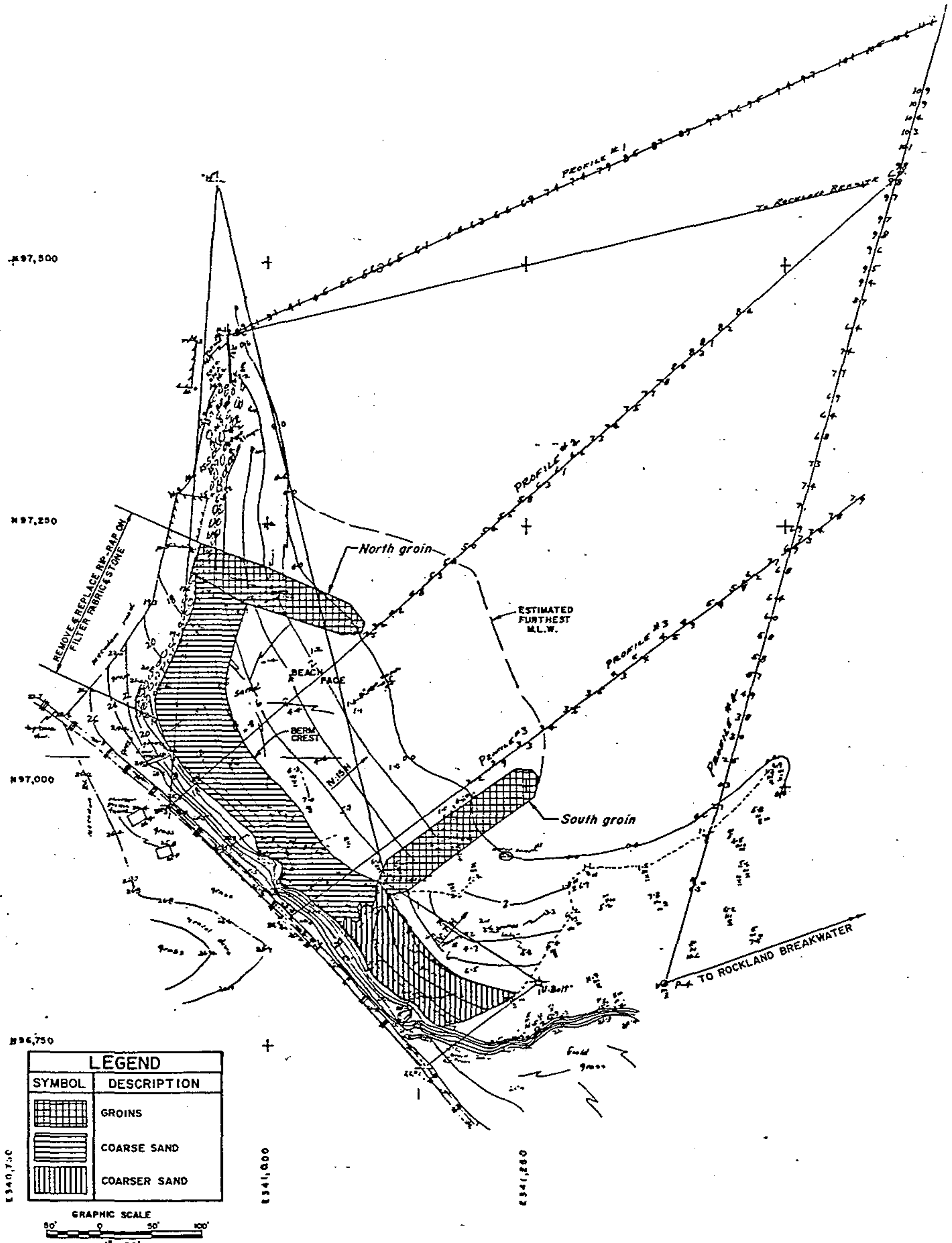
CONCEPT I

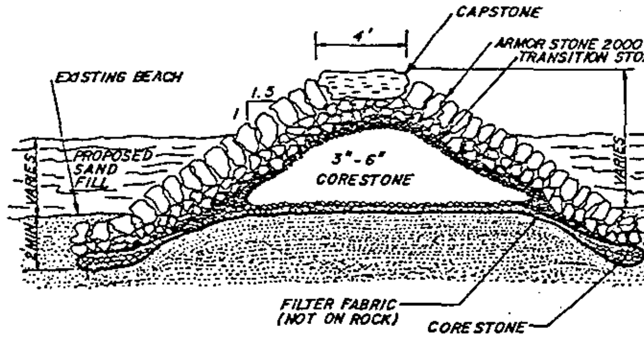
PROTECTIVE BEACH WITH SOUTH GROIN

OCTOBER 1985

FIGURE 16

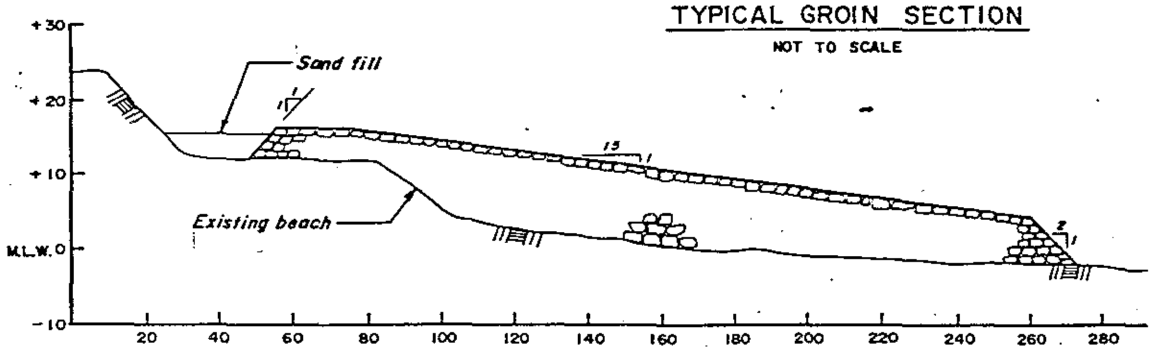
CORPS OF ENGINEERS U. S. ARMY





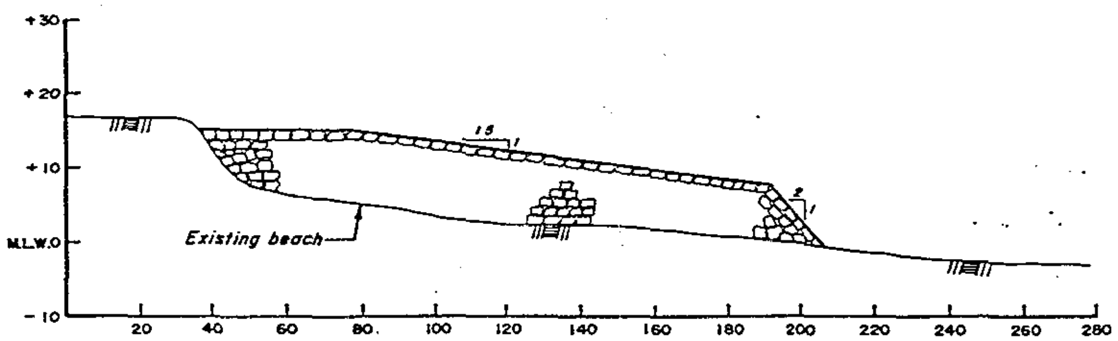
TYPICAL GROIN SECTION

NOT TO SCALE



SOUTH GROIN PROFILE

SCALE: HORIZ. 1" = 20' VERT. 1" = 10'



NORTH GROIN PROFILE

SCALE: HORIZ. 1" = 20' VERT. 1" = 10'

FOR GENERAL NOTES SEE FIGURE 3

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

SOUTH END BEACH EROSION STUDY

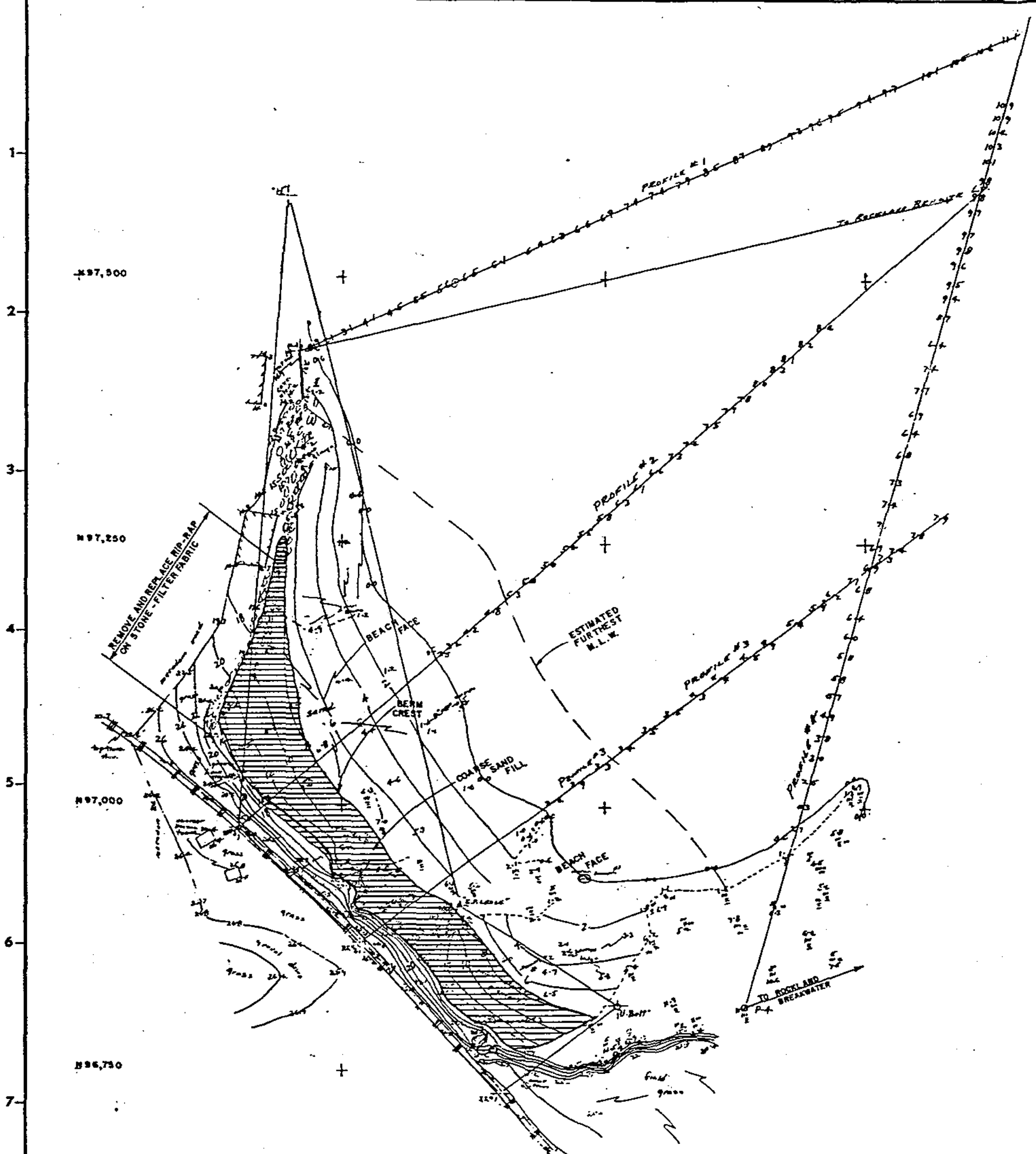
ROCKLAND, MAINE

CONCEPT II

PROTECTIVE BEACH WITH NORTH AND SOUTH GROINS

OCTOBER 1985

FIGURE 17



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

SOUTH END BEACH EROSION STUDY

ROCKLAND, MAINE

CONCEPT III

PROTECTIVE BEACH - NO GROINS

OCTOBER 1985

FIGURE 18

VIII. RECOMMENDATIONS

The Division Engineer recommends construction of Plan 1, the recommended plan as discussed in the previous section. He finds it the most practical, economical and environmentally suitable plan of improvement for South End Beach. Approval of the beach erosion control project by the Chief of Engineers is recommended under the provisions of Section 103 of the River and Harbor Act of 1962, as amended. The project, with such modifications that the Chief of Engineers may deem advisable, is estimated to have a total first cost of $400,000, as shown in Table 5.

The Division Engineer further recommends that Federal participation be authorized in the amount of $200,000, or 50 percent of the first cost of construction of the project, together with periodic nourishment (500 cubic yards of sand at $4,500 per year) over a 50-year period of economic analysis. The non-Federal share of the first cost is $200,000. (For detailed cost information, see Appendix 4).

Federal participation in the recommended project is subject to the following conditions of local cooperation:

The local sponsor (city of Rockland) must agree that it will:

a. Contribute prior to construction, in cash, 50 percent of the project first cost, including the cost of plans and specifications (total project first costs are currently estimated to be $400,000). A final cost apportionment would be made after actual costs and values have been determined.

b. Assume full responsibility for all project costs in excess of the Federal cost limitation of $1,000,000, which includes the cost of construction and periodic sand nourishment for the 50-year life of the project and all study costs.

c. Maintain continued public ownership and access of the beach and shore and its administration for public use during the 50-year economic life of the project by establishing, prior to construction, a boundary control line which would separate public property from private property used for the realization of the public benefits upon which Federal participation is based.

d. Provide without cost to the United States all lands, easements, and rights-of-way necessary for project construction and subsequent maintenance of the project.

e. Hold and save the United States free from all claims for damages that may arise before, during or after prosecution of the work and subsequent maintenance of the project other than damages due to the fault or negligence of the United States or its contractors.

f. Maintain the protective measures during the economic life of the project as may be required to serve their intended purposes by contributing, in cash, 100 percent of the cost of groin and riprap maintenance and 50 percent of the cost of periodic nourishment for the 50-year economic life of the project. Such contributions would be made prior to each nourishment operation. If the Federal limitation of $1,000,000 is reached, the non-Federal interests would be responsible for 100 percent of the cost of periodic nourishment. The estimated amount of periodic sand nourishment is 500 cubic yards annually. Nourishment monetary contributions are to be made prior to each nourishment operation.

g. Control water pollution under the jurisdiction of the city of Rockland to the extent necessary to safeguard the health of bathers.

h. Comply with the requirements of non-Federal cooperation specified in Sections 210 and 305 of Public Law 91-646, approved 2 January 1971, entitled, "The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970".

i. Comply with Title VI of the Civil Rights Act of 1964 (78 Stat 241) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations.

j. Provide diversion of freshwater drainage away from the beach.

k. Provide additional parking areas, as needed, to permit enjoyable use of the improved beach and avoid nuisance impacts on the neighborhood.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the respective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before authorization and/or implementation funding.

Thomas A. Rhen
Colonel, Corps of Engineers
Division Engineer

ACKNOWLEDGMENTS

The New England Division (NED), U.S. Army Corps of Engineers, prepared this report under the overall direction of Colonel Thomas A. Rhen, Division Engineer, and Joseph L. Ignazio, Chief of the Planning Division. The Coastal Development Branch of the Planning Division had overall responsibility for the study under the supervision of its Chief, John T. Smith and by Section Chief, Thomas C. Bruha.

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The report was prepared for publication by NED's Word Processing Center under the supervision of Patricia A. Wysocki and by NED's Reprographics Branch under the supervision of Robert H. Bentham.

IX. ENVIRONMENTAL ASSESSMENT (FONSI, AND 404 EVALUATION) AND SUPPLEMENT.

A. Introduction

This document concerns the proposed beach erosion control project at South End Beach, Rockland, Maine. The study was undertaken by the New England Division (NED), U.S. Army Corps of Engineers under the authority of Section 103 - Beach Erosion Control, of the River and Harbor Act of 1962, as amended. It was initiated as a result of a letter request from the city of Rockland, in April 1982. NED has examined environmental values as part of the planning and development of the proposed plan in compliance with the National Environmental Policy Act of 1969 and other environmental laws and statutes. The following sections provide an assessment of environmental impacts and alternatives considered, plus additional information applicable to Section 404 Evaluation requirements.

B. The Study Area

South End Beach is located at the southwestern end of the Penobscot Bay, roughly midway along the coast of Maine. The beach faces on Rockland Harbor, just south of Rockland Center, within walking distance of the city business district. The area of study (See Figure 3) covers approximately 700 feet of shoreline and includes approximately 450 feet of usable beach frontage along its southern through north central portions. The study area is bordered on the northern end by an embankment of large granite blocks and on the southern end by a natural rocky headland known as Atlantic Point. The beach is divided into two bathing areas (southern and northern) by large rock outcrops extending from the backshore to approximately mean low water. Existing dry beach space at high tide varies from 10 feet wide at the northern end of the beach to virtually zero near the southern end.

The foreshore consists of gravelly and mostly medium-to-coarse sand with shells and is quite rocky in the seaward section of its southern portion as well as at the beach's northern boundary. The southern intertidal area is approximately 2/3 of an acre in size, while the northern intertidal area comprises about 1.5 acres. The segment above mean high water, in back of both these areas ranges from 0-10 feet wide, comprising a total of about 3,500 square feet. The backshore is protected by a steep 12-foot-high embankment covered with grass and small bushes. There is evidence of storm-induced erosion at the foot of the embankment. Beyond the embankment is a city-owned piece of land about 1/3 acre in size where a small picnic area with two or three picnic tables has been developed. Only street parking is available at present, but there is potential for a small parking area.

C. Project Description

The proposed plan (Plan 1 in the main report) is intended to provide the necessary erosion protection and recreational benefits while minimizing impact on the seaward biologically productive rocky section of the southern intertidal area. The 450 feet of usable beach would be divided by a groin into the northern and southern portions (See Figure 16). On the northern portion, a coarse grade of sandfill would be fixed on the existing beach from the existing backshore embankment seaward, a distance of 50 feet (berm-width) at a height of 15 feet above MLW, then sloping at a rate of approximately 15 horizontal feet to 1 vertical foot until it meets the existing topography approximately 3 to 5 feet below mean low water, for a total sandfill width of approximately 275 feet. The groin would be located along the south edge of the sandfill oriented to make maximum use of the existing rock outcrop to minimize stone quantities and environmental impact. The primary purpose of the groin would be environmental protection, by compartmentalizing South End Beach into a northern bathing area and a southern environmental area thus preventing sand movement from the former to the latter. The groin would also retard the small potential for littoral movement of sand material to the south by in-harbor generated waves from the northeast.

On the southern portion of the beach, sandfill would be placed from the existing backshore embankment seaward, a distance of 50 feet (berm-width) at a height of 15 feet above MLW, then sloping at a rate of approximately 7 horizontal feet to 1 vertical foot until it meets the existing beach approximately 2 feet above mlw, for a total sandfill width of approximately 140 feet. The steeper slope, effected by using a much coarser fill than on the northern beach, with termination at about 2 feet above MLW would prevent encroachment on the biologically productive rocky seaward section of the southern intertidal area. The groin between the two beach segments would be made of native stone. The existing rock outcrop would separate the two beach segments for the width of the 50-foot sand berm. The groin would extend from this point at a slope similar to the northern beach slope of 15 horizontal feet to 1 vertical foot, with the nose sloping at 2 horizontal feet to 1 vertical foot for a total groin length of approximately 180 feet. The top elevation would be one foot higher than the northern beach profile to ensure the groin's effectiveness in preventing sand movement to the south. The groin would terminate at approximately 3 feet below MLW. The sides of the groin would slope at 1.5 horizontal feet to 1 vertical foot. The width of the crest of the groin would be 4 feet; the width of the base of the groin would range from about 40 feet in the upper section to about 30 feet at the toe. The total area covered by sandfill and groin would be approximately 2.5 acres.

As part of the proposed plan, the jagged, relatively ineffective stone revetment along the northern boundary of South End Beach would be corrected. Random placement of the large, sharply angular blocks make this a safety hazard, and the poor placement and lack of a base has allowed erosion behind it. The blocks would be removed and stockpiled. The slope would then be roughly graded and a base of stone established. The stockpiled stone would then be replaced in a coherent manner for increased erosion protection.

No terminal groin at the southern end of the southern beach area was considered necessary, due to the presence of a natural outcrop there. A northern terminal groin, at the northern boundary of South End Beach, was considered, but further consideration deferred until after observing the fate of any sandfill placed on the beach.

Approximately 27,000 cubic yards of clean, coarse sandfill, environmentally compatible with the existing beach, would be obtained from an upland site or sites to provide a total dry beach area above mean high water (MHW) of approximately 68,450 square feet. The sand would be trucked to the beach for placement, requiring about 2,700 truck trips for delivery. Approximately 2,250 cubic yards of stone would be required for groin construction and would be obtained from a local land source or sources and trucked to the site, requiring about 225 truck trips for delivery. Stone sizes would range from 3 to 6 inches in diameter for the core stones, to 2 to 3 feet in diameter for the armorstone. An additional 150 cubic yards of stone, 3 to 6 inches in diameter, would be required to provide the base for restructuring the stone revetment at the northern boundary of the beach, resulting in an additional 15 truck trips.

The sand would be dumped above mean low water and distributed over the beach. The stone would be dumped at the location of the groin structure and northern boundary revetment and be placed by equipment.

The proposed work would begin in mid-April of 1987, and would take approximately 3 months to complete.

Renourishment of approximately 5,000 cubic yards of sandfill every 10 or so years, depending on storm frequency and severity, would be placed on the beach, to maintain it to specifications. It would be placed above mean high water and allowed to work its way seaward.

Consideration should be given, as part of local participation in the project, to enhancing the value of the rocky, biologically productive, seaward section of the southern intertidal area, by providing in the backshore park area pictures and descriptions of what is there. Interpretive information on the local geology and the historic past of the South End Beach area, which encompassed shipyards and limekilns, could also be presented.

D. Purpose and Need for the Project

The purpose of the project is twofold: to restore a recreational beach where one presently only minimally exists, but where the demand is clear; and to protect this beach, the city-owned backshore park and the backshore rail line from the effects of erosion.

An improved South End Beach would provide easily accessible recreational opportunity for persons from all over Knox County, in which Rockland is located. It is estimated that it would attract as many as

1,000 to 1,100 visitors on a peak summer day. The improved beach would serve to complement Rockland's spirited recreational program and its downtown revitalization project. It is within walking distance of downtown Rockland. In addition, since the opening of the wastewater treatment plant in Lermond Cove in 1978, the waters of Rockland Harbor have become steadily cleaner, thus turning renewed attention to the potential for recreational bathing in the harbor's waters. An improved South End Beach would enhance the lives of residents in its immediate vicinity. Many visitors would be from this low income area, where the number of persons possessing incomes below the poverty level is about double the statewide average. Few have their own private means of transportation.

E. Affected Environment

a. Marine ecosystem - The water quality in Rockland Harbor, in the vicinity of South End Beach, is influenced by both flows into the Penobscot River and Bay and by local discharges. It may be approximated by data obtained about 0.5 mile south of Atlantic Point, on a weekly basis, during the period extending from May into September of 1984. (Data from Maine Department of Environmental Protection - Bureau of Water Quality Control - Personal Communication). Nineteen weekly samples were taken. The median total coliform count was 290; 9 out of 19 samples exceeded 330. The median fecal coliform count was 15; 7 out of 19 samples exceeded 70; 4 samples exceeded 500. A fecal coliform count of 200 or more is considered unacceptably risky for swimming (Maine DEP - BWQC). Water quality in the harbor has significantly improved since 1978, when the wastewater treatment plant opened in Lermond Cove. An indication of this improvement was the first-time scheduling of a harbor swim event in 1984 at the annual Rockland Seafood Festival. The mean range of the tide and the mean spring range of the tide at Rockland are 9.7 and 11.2 feet, respectively.

A site visit to South End Beach was made on April 4, 1985, to conduct biological sampling at the beach and to quantitatively evaluate the existing beach environment. The detailed data obtained may be found following the Section 404(b)(1) Evaluation, in Biologist Sampling and Field Survey Results.

South End Beach provides a typical New England rocky intertidal habitat on the seaward section of its southern portion and also on a smaller area along the beach's northern boundary. The northern portion of South End Beach and the landward section of the southern portion provide a sandy beach intertidal habitats. The rocky intertidal seaward section of the southern beach portion had approximate densities of 1,825 blue mussels (*Mytilus edulis*) per square meter (mean length=4.41 cm). The northern boundary rocky intertidal area contained approximately 2,300 *Mytilus edulis* per square meter (mean length=5.15 cm). Both of these densities define highly productive assemblages of mussels and associated organisms. In addition to *Mytilus edulis*, there was a profusion of barnacles (Balanus sp.), common periwinkles (Littorina littorea), rockweed (Fucus vesicioles), and knotted wrack (Ascophyllum nodosum) on the rocky intertidal areas. The northern portion of the beach and the landward section of the southern beach portion contained an impoverished benthic intertidal sand assemblage (see data from Stations 1, 2, 4 and 5, and 7, respectively, in Biologist Sampling and Field Survey Results. These areas contained only two species of polychaetes. Subtidally, the benthic population at South End Beach is assumed to be productive, based on two cores taken off the northern portion of the beach (see data from Station #3 and 6 in Biologist Sampling and Field Survey Results. No soft clams were found anywhere at South End Beach.

The South End Beach area is utilized by fishermen and the predominant fish caught are Atlantic mackerel (Scomber scombrus) and pollack (Pollachius sp.) (U.S. Fish and Wildlife Service - Personal Communication). No bird species nest on South End Beach. The beach is not an important resting or feeding place.

b. Terrestrial ecosystem - The adjacent terrestrial habitat at South End Beach is dominated by a railroad track along the backshore embankment, fringed by grasses and shrubs.

c. Threatened and endangered species - Except for occasional transient peregrine falcons, which may briefly stop there, no threatened or endangered species utilize the study area.

d. Archaeological and historical resources - As the present beach and backshore have been heavily eroded since the 19th century, no intact terrestrial or underwater archaeological resources would be anticipated within the project impact area.

F. Environmental Consequences

The proposed plan would entail placing sandfill along the approximately 450 feet of usable beach, construction of a 180-foot long groin to separate with the sandfill width substantially limited on the southern beach portion; the northern and southern portions of the beach and reconstruction of the stone revetment at the northern boundary of the beach. The project would cover a total of approximately 2.5 acres in area.

a. Marine Ecosystem - The toe of the sandfill on the northern portion of the beach would extend to approximately 3 to 5 feet below the present MLW line. There would be minimal impact on the 1.5 acres of mostly impoverished benthic intertidal community buried on this beach portion. A small amount of rocky intertidal organisms and habitat might be lost at the northern boundary. About 0.5 acre of productive subtidal community and habitat would be buried and permanently lost. Some colonization by intertidal organisms would take place on the newly developed sandy intertidal habitat; this community would likely be at least as productive as that on the presently existing sandy intertidal zone there.

On the southern portion of the beach, the sandfill would end at approximately 2 feet above MLW, or about 140 feet from the backshore embankment, burying the approximately 0.5 acre of relatively unproductive sandy intertidal community. Since the productive rocky intertidal habitat begins at about the 44-meter mark (approximately 145 feet) from the embankment (see Biologist Sampling and Field Survey Results), there would be essentially no encroachment by the sandfill upon this desirable natural feature of this beach portion.

The groin between the two beach portions would make maximum possible use of the existing rock outcrop already there, and employ natural stone in construction. Burial of about 3,700 square feet of existing sandy and rocky intertidal habitat and organisms and 2,600 square feet of subtidal habitat and organisms would be affected by construction of the approximately 180-foot long by an average 35-foot base-width (6,300-square foot) groin. Little would be lost from the already impoverished sandy intertidal habitat. The subtidal habitat and organisms would be permanently buried and lost. Rocky habitat organisms would likely recolonize the groin, but would probably not fully compensate for losses from natural rocky intertidal habitat. The long-term impact of the groin would be positive, as it would serve to separate and protect the natural rocky intertidal community on the southern beach portion from the northern bathing beach portion of the South End Beach system by minimizing sand movement to the southern beach portion.

Correction by replacement of stones at the northern border of South End Beach would result in minimal impacts. There would be a loss of rocky intertidal organisms, but recolonization on the improved structure would take place.

Finally, not placing sandfill on the seaward rocky section of the southern intertidal area, and isolating the northern beach portion's sandfill from it with a groin, is a positive aspect of the proposed plan. It would allow the continued existence of a productive biological community. This area would continue to be available to those who wish to enjoy the shoreline in its natural state; and the opportunity would exist for enhancing its value with the provision of interpretive displays located in the backshore park.

Renourishment of approximately 5,000 cubic yards of sand above mean high water every 10 or so years should not significantly affect the local marine ecosystem. The 5,000 cubic yards spread along the upper edge of 450 linear feet of beach would equal about 11 cubic yards per linear foot of beach. Little of the sand would reach into the subtidal zone beyond the northern bathing beach or into the biologically productive section of the southern beach portion's intertidal zone.

No significant impact on the water quality would be anticipated as a result of the project work; minor and short-term turbidity increases nearshore would be possible during construction. No water quality impacts would be expected to result from periodic renourishment.

b. Terrestrial Ecosystem - No short- or long-term effects on terrestrial resources would be anticipated as a result of project implementation.

c. Threatened and endangered species - No threatened or endangered species would be impacted by the proposed action.

d. Archaeological and historical resources - As the present beach and backshore have been heavily eroded since the 19th century, no intact terrestrial or underwater archaeological resources would be anticipated within the project impact area. For this reason, we would expect the proposed action to have no effect upon significant historic or archaeological resources. This was confirmed by telephone coordination with the Maine Office of Historic Preservation.

e. Construction Impact - Construction activities at South End Beach would result in increased noise and dust levels, both at the site and along transportation routes for the trucking of sandfill and stones. The estimated total of 3,000 truck trips would also prove to be a hindrance to traffic. However, proper scheduling of the construction activities estimated at 3 months, should avoid the important post-July 1 peak tourist season traffic. Recreational use of the beach and the backshore park would be limited during construction, but with completion expected before the peak of the beach use season (July and August), significant impacts would be avoided. Construction-related effects (noise, dust, traffic, beach and park use) would also be expected during periodic renourishment.

With project implementation, the positive impacts of significantly enhanced recreational opportunity at the beach, protection of the beach, park facilities and rail line against erosion would be realized.

f. Secondary and cumulative impacts - With project implementation, traffic in the vicinity of the beach and park and on access routes to it would increase, having some negative effect on the immediate neighborhood. Too large crowds could degrade the beach and park use experience. Limiting use to some capacity number of people at one time could ameliorate these potential effects. Current availability of parking would be a limiting factor to beach attendance. Restraint from overproviding additional parking opportunities could help keep attendance from becoming excessive.

G. Alternatives

The alternatives for this project include a "no action" alternative; a variation of the proposed plan with the addition of a terminal groin at the northern end of the beach; and a plan filling the northern beach portion as in the proposed plan, but extending the sandfill on the southern beach portion to be similar to that proposed to be placed on the northern beach portion, thus burying the biologically productive rocky seaward section of the southern intertidal zone, and with no groin separating the two portions of the beach.

Eliminated as unfeasible during preliminary plan evaluation were:

a. Establish guidelines for beach use - Generally effective only for environmentally sensitive areas where protection is the primary purpose of the project. Would not address either the erosion-protection or beach improvement needs at South End Beach.

b. 25-foot berm-width plans - Would provide inadequate protection for the backland and inadequate dry beach area for recreational needs.

c. 75-foot berm-width plans - Would intrude into productive southern intertidal and further into productive northern subtidal areas, while the additional dry beach space would be greater than the projected usage and therefore uneconomical.

d. Construct groins to compartmentalize the beach to trap littorally transported sand - Groins would only have application as an adjunct to a protective beach, to prevent losses of placed sandfill. Groins by themselves would have little capability to reduce erosion and since there is no existing significant littoral transport, no capability to provide improved recreational beach opportunities by trapping littorally transported sand and adding to the existing beach.

e. Offshore breakwater - Rockland Breakwater already exists offshore of South End Beach, providing significant protection. An additional breakwater structure could further protect the existing minimal beach recreational opportunity and the backshore park and rail line, but would not address the needed recreational beach improvement.

f. Rock revetment along the backshore embankment - Would protect the backshore park and rail line, but provide no protection to, and likely even accelerate erosion of, the existing beach - thus negatively impacting even the minimal existing beach recreational opportunity. Would not at all address the needed recreational beach improvement.

Details of the considered alternatives follow:

1. No action alternative - This alternative to the proposed work would avoid the impacts associated with project implementation, but would leave the beach in an essentially minimally usable state for most water-related recreation, and would expose the existing beach and the backshore park facilities and adjacent rail line to increasing vulnerability to erosive processes.

2. (Plan 1) - A variation of the proposed plan with the addition of a terminal groin at the northern end of the beach - The presence of the existing stone revetment at the northern end of the beach, and slope erosion behind it, indicates that this historically has been a primary erosion area. To eliminate or minimize this problem, a groin would be placed to restrict sand movement to the north and, by its orientation, protect this section of the beach. The groin would intersect the rehabilitated riprap slope at this location (see Figure 17) and extend a length of approximately 165 feet, to approximately MLW. The amount of intertidal area covered by sandfill and groins would be not significantly different from that in the proposed plan, and no significant additional incursion upon the northern boundary's biologically productive rocky intertidal community would be anticipated. About 5 percent less sandfill, but approximately twice as much stone, would be used. This would result in a net increase of about 250 truck trips. The implementation of a northern groin in the proposed plan was considered to be premature, however, and it was decided to leave this consideration open until after observing the fate of any sandfill placed on the beach.

3. (Plan 3) - Filling the northern beach as in the proposed plan, but extending the sandfill on the southern beach portion to be similar to that proposed to be placed on the northern beach, thus burying this biologically productive rock seaward section of the southern intertidal zone 1 and with no groin separating the two portions of the beach - This alternative (see Figure 18) would bury a productive biological community on the rocky seaward section of the southern intertidal zone and replace the existing habitat with a sandy substrate, which would eventually yield a relatively unproductive sand assemblage. The potential for enhancing the value of this rocky productive section of the southern beach portion with interpretive displays, located in the backshore park, would be lost. About 40 percent more sandfill would be required than in the proposed plan, leading to an additional 1,100 truck trips for delivery, minus 400 truck trips for no groin construction, for a net increase of 700 truck trips. This alternative was rejected because of the negative environmental impacts associated with it.

H. Coordination

The city of Rockland initiated this study in a letter to the Corps in April 1982. Coordination with city officials has been taking place since the beginning of the study. The Corps of Engineers has also consulted with several resource agencies to gather information for the study and to keep them informed on its progress. Formal coordination with the U.S. Fish and Wildlife Service, Environmental Protection Agency, National Marine Fisheries Service, the Maine Departments of Marine Resources and Environmental Protection, the Maine State Planning Office and the Maine Geological Survey was initiated by letter dated April 1, 1985. A coordinated site visit to South End Beach took place on April 17, 1985, and was attended by the U.S. Fish and Wildlife Service, Environmental Protection Agency, National Marine Fisheries Service, the Maine

Departments of Marine Resources and Environmental Protection, the Maine State Planning Office and city of Rockland officials. Meetings led by Corps of Engineers representatives took place on this date at both the Rockland City Hall and at the beach. Formal coordination with the Maine Historical Preservation Commission was initiated by letter dated May 8, 1985. Correspondence received to date may be found in Appendix 1, Pertinent Correspondence.

COMPLIANCE WITH ENVIRONMENTAL FEDERAL STATUTES AND EXECUTIVE ORDERS

Statutes	Compliance
1. Archaeological and Historic Preservation Act, as amended, 16 U.S.C. 469 et seq.	1. No cultural resources would be impacted by the proposed action.
2. Clean Air Act, as amended, 42 U.S.C. 7401 et seq.	2. Submission of this report to the Regional Administrator of the Environmental Protection Agency (EPA) for review constitutes compliance with the Act.
3. Clean Water Act of 1977 (Federal Water Pollution Control Act), as amended, 33 U.S.C. 1251 et seq.	3. A Section 404(b)(1) Evaluation has been prepared as part of this document. A Water Quality Certificate under Section 401 of this Act will be applied for.
4. Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1451 et seq.	4. A CZM consistency determination concurrence will be sought from the State.
5. Endangered Species Act of 1973, as amended, 16 U.S.C. 1531 et seq.	5. Coordination with the U.S. Fish Wildlife Service and the NMFS of the proposed action has yielded no formal consultation requirements.
6. Estuary Areas Act, 16 U.S.C. 1221 et seq.	6. Coordination with the Department of Interior constitutes compliance with this Act.
7. Federal Water Project Recreation Act, as amended, 16 U.S.C. 4601-12 et seq.	7. Same as above.
8. Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661 et seq. Department of Environmental	8. Coordination with the U.S. Fish and Wildlife Service and the NMFS constitutes compliance of this action.
9. Land and Water Conservation Fund Act of 1965, as amended, 16 U.S.C. 4601-3 et seq.	9. Coordination with the Department of the Interior constitutes compliance with this Act.
10. Marine Protection, Research, and Sanctuaries Act of 1972, as amended, 33 U.S.C. 1401 et seq.	10. Not Applicable.
11. National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 et seq.	11. No cultural resources would be impacted by the proposed action.
12. National Environmental Policy Act of 1969, as amended, 42 U.S.C. 432 et seq.	12. The preparation of this document constitutes compliance with this Act.
13. Rivers and Harbors Act of 1899, as amended, 33 U.S.C. 401 et seq.	13. Not Applicable.
14. Watershed Protection and Flood Prevention Act, as amended, 16 U.S.C. 1001 et seq.	14. Not Applicable.
15. Wild and Scenic Rivers Act, as amended, 16 U.S.C. 1271 et seq.	15. Not Applicable.

Executive Orders	Compliance
1. Executive Order 11988, Floodplain Management, 24 May 1977.	1. Not Applicable.
2. Executive Order 11990, Protection of Wetlands, 24 May 1977.	2. Not Applicable.
3. Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, 4 January 1979.	3. Not Applicable.

SOUTH END BEACH, ROCKLAND, MAINE
FINDING OF NO SIGNIFICANT IMPACT

The proposed beach erosion control project at South End Beach, Rockland, Maine would provide for the placement of approximately 27,000 cubic yards of clean, coarse sandfill along approximately 450 feet of the existing beach. The beach would be divided by a groin into a northern bathing area and a southern environmental area. The area covered by sandfill and groin would be approximately 2.5 acres. On the northern portion, sandfill would be placed, from the existing backshore embankment seaward, a distance of 50 feet (berm-width) at a height of 15 feet above MLW, then sloping at a rate of approximately 15 horizontal feet to 1 vertical foot to approximately 3 to 5 feet below MLW, for a total sandfill width of approximately 275 feet. The groin would be located along the south edge of this sandfill. Its primary purpose would be to compartmentalize the beach into the two separate segments, and reduce the potential for sand movement into the southern beach portion. The existing rock outcrop between the two segments would separate them for the width of the 50-foot sand berm. The groin would extend from this point seaward, at a slope of 15 horizontal feet to 1 vertical foot, with a base-width ranging from 40 feet in the upper section to 30 feet at the toe, and would end at approximately 3 feet below MLW, for a total length of approximately 180 feet. On the southern portion of the beach, sandfill would be placed, from the existing backshore embankment seaward, a distance of 50 feet at a height of 15 feet above MLW, then sloping at a rate of approximately 7 horizontal feet to 1 vertical foot to approximately 2 feet above MLW, for a total sandfill width of approximately 140 feet. This steeper slope and abbreviated sandfill width would prevent encroachment on the biologically productive rocky seaward section of the southern intertidal area. Also, as part of the proposed plan, the jagged, relatively ineffective stone revetment along the northern boundary of South End Beach would be corrected by replacement of the stones in a coherent manner on a newly graded slope with a new stone base.

The proposed plan would restore a recreational beach where one presently only minimally exists, and protect this beach, the city-owned backshore park and the backshore rail line from the effects of erosion. It would allow the continued existence of a productive biological community on the southern beach portion, and provide the opportunity for enhancing the value of this feature of the beach with the provision of interpretive displays in the backshore park.

There would be minimal impacts to the approximately 1.5 acres of mostly impoverished benthic intertidal community to be covered at the northern beach portion. Approximately 0.5 acre of productive subtidal community and habitat of this beach portion, to approximately 3 to 5 feet below present MLW, would be buried and permanently lost. On the southern portion of the beach, about 0.5 acre of relatively unproductive sandy intertidal habitat and organisms would be buried, but there would be essentially no encroachment by sandfill on the biologically productive rocky section of the intertidal zone which begins approximately 145 feet from the backshore embankment. The groin between the two beach portions would bury about 3,700 square feet of existing sandy and rocky intertidal habitat and organisms and 2,600 feet of subtidal habitat and organisms, but would create a habitat of a rocky character. Little would be lost from the already impoverished sandy intertidal habitat. The subtidal habitat and organisms would be permanently buried and lost. Rocky habitat organisms would likely recolonize the groin, but would probably not fully compensate for losses from natural rocky intertidal habitat. Correction by replacement of stones at the northern border of South End Beach would result in minimal impacts. There would be a loss of rocky intertidal organisms, but recolonization on the improved structure would take place. No significant impact on the water quality would be anticipated as a result of the project work. Minor and short-term turbidity increases nearshore are possible during construction. No effects are expected on terrestrial or historic and archaeological resources. Construction impacts would be minor, involving increased noise and dust at the project site and along the material haul routes, and traffic effects along these same routes. Use of park facilities would be impaired during construction. Construction, and all construction impacts, would cease prior to the peak traffic and peak beach use summer season. No significant effects would be anticipated to result from periodic renourishment.

After a complete, in-depth study and with coordination from other agencies, I have determined that the proposed beach erosion control project would not have any significant impacts which would necessitate the preparation of an Environmental Impact Statement.

Date	Thomas A. Rhen Colonel, Corps of Engineers Division Engineer

SECTION 404(b)(1) FACTUAL DETERMINATION
AND FINDING OF COMPLIANCE
SMALL BEACH EROSION CONTROL PROJECT
SOUTH END BEACH
ROCKLAND, MAINE

References

a. Section 404(b) of Public Law 92-500, as amended, Clean Water Act.

b. 40 CFR, Part 230, Subparts A, B, C, D, E, F, G, and H dated 24 December 1980.

I. Project Description

a. Location

The proposed project is located at South End Beach, Rockland, Maine, roughly midway along the coast of Maine.

b. General Description

The proposed plan consists of the placement of approximately 27,000 cubic yards of clean coarse sandfill along approximately 450 feet of the existing beach. The beach would be divided by a groin into a northern bathing area and a southern environmental area. On the northern portion, sandfill would be placed, from the existing backshore embankment seaward to approximately 3 to 5 feet below mean low water (MLW). The groin would be along the southern edge of this sandfill, and extend to approximately 3 feet below MLW. On the southern portion of the beach, sandfill would be placed, from the backshore embankment seaward only to approximately 2 feet above MLW, to prevent encroachment on the biologically productive rocky seaward section of the southern portion's intertidal zone. The jagged, relatively ineffective stone revetment along the northern boundary of South End Beach would be corrected by replacement of the stones in a coherent manner on a newly graded slope with a new stone base.

c. Authority and Purpose

The purpose of the project is to restore a recreational beach area where one presently only minimally exists, and to protect this beach, the city-owned backshore park and the backshore rail line from the effects of erosion. Project authority is conferred in Section 103 of the 1962 River and Harbor Act, as amended. The project study was initiated as a result of a letter request from the city of Rockland, in April, 1982.

d. General Description of Dredged or Fill Material

The sandfill material would be coarse, clean, free of any harmful contaminants and composed of naturally occurring sand from an upland site or sites. Approximately 27,000 cubic yards of sandfill would be used. Approximately 2,250 cubic yards of stone would be used for constructing the groin and the base of the stone revetment at the northern boundary of the beach, also to be obtained from an upland site or sites. Stone sizes would range from 3 inches to 3 feet in diameter.

e. Description of the Proposed Discharge Site

The proposed sandfill placement site is shown on Figure 3. The intertidal habitat on the northern beach portion and on the landward section of the southern beach portion proposed to be filled comprises gravel and mostly medium-to-coarse sand with shells, with a small amount of rocky intertidal habitat at the beach's northern boundary, and in the vicinity of where the groin would be placed, totalling approximately 2 acres in area. Additionally, 0.5 acre of subtidal habitat on the northern beach portion would be filled. Construction would take place over about a 3-month period beginning in mid-April of 1987.

f. Description of Disposal Method

The sand and stone would be delivered by truck to the beach. The sand would be dumped above mean low water and distributed over the beach. The stone would be dumped at the location of the groin structure and northern boundary revetment and be placed by a crane.

II. Factual Determinations

a. Physical Substrate Determinations

The proposed discharge site would be transformed from a mostly sandy intertidal and subtidal habitat to all sandy intertidal and supratidal habitat and, at the groin structure, to a rock substrate. The stone revetment at the northern boundary of the beach would be reconstructed in kind.

The substrate and slope would be changed from a gently sloping area below the 12-foot high backshore embankment to one characterized by a 50-foot-wide sand berm extending seaward from the embankment, at a height of 15 feet above MLW, then, on the northern beach portion, sloping at a rate of 15 horizontal feet to 1 vertical foot until it meets the existing beach approximately 3 to 5 feet below MLW, for a total sandfill width of approximately 275 feet. On the southern beach portion, the sandfill would slope from the berm at a rate of 7 horizontal feet to 1 vertical foot until it meets the existing beach approximately 2 feet above MLW, for a total sandfill width of approximately 140 feet. The existing rock outcrop between the two beach portions would separate them for the width of the

50-foot sand berm. The groin would extend from this point seaward at a slope of 15 horizontal feet to 1 vertical foot, with a base-width ranging from 40 feet in the upper section to 30 feet at the toe, and would end at approximately 3 feet below MLW, for a total length of approximately 180 feet. The jagged, relatively ineffective, stone revetment along the northern boundary of South End Beach would be corrected by replacement of the stones in a coherent manner on a newly graded slope with a new stone base.

The fill material would be clean, coarse sand and stone. Sand and stone would be obtained from an upland site or sites.

The sandfill would extend into the subtidal zone to approximately 3 to 5 feet below MLW on the northern beach portion. It is very unlikely that any significant amount of sand will move below the MLW line on the southern beach portion.

The placement of sandfill, construction of the groin, and reconstruction of the revetment would bury about 2 acres of intertidal habitat and 0.5 acre of subtidal habitat and associated organisms. The intertidal habitat contains mostly an impoverished benthic sand assemblage, (comprising only two species of polychaetes) with a small amount of productive rock assemblage. Subtidally, the population is assumed to be productive, based on two cores taken off the northern portion of the beach (see <u>Biological Sampling and Field Survey Results</u>). No soft clams are found anywhere at South End Beach.

b. <u>Water Circulation, Fluctuation and Salinity Determinations</u>

Current patterns, circulation, normal water fluctuation and the tidal regime would not be altered in such a manner as to result in adverse impacts on the environment. Construction of the groin should result in no significant effect on areas surrounding the beach, either updrift or downdrift, as there is currently very little littoral material moving in the area. The groin would protect the southern beach portion against sand movement from the northern beach portion.

Chemical and physical characteristics, including salinity, pH, dissolved oxygen levels, nutrients, clarity, color and odor would not be permanently changed from present conditions. There would be no introduction of nutrients that would result in the possibility of increased eutrophication.

c. <u>Suspended Particulate/Turbidity Determinations</u>

As a result of construction, a temporary minimal increase in suspended particulate and turbidity levels is expected. Any sandfill material would settle out quickly due to the large grain size of the sand. The discharge would not violate such water quality standards as are appropriate and applicable by law.

Chemical and physical properties of the water column would not be adversely affected. Light penetration may be temporarily reduced due to minor increases in turbidity. Dissolved oxygen levels should not be reduced by the proposed discharge. There would be no introduction of toxic metals or pathogens and organic loads would not increase.

The processes of primary production and photosynthesis would not be adversely affected by any increases in suspended particulates. Suspension and filter feeders would also not be adversely affected because of the minimal amount of material expected to enter the water column.

d. Contaminant Determinations

All material proposed for placement would be clean. It would come from an inland source or sources. It would be free of harmful contaminants that might adversely impact the aquatic environment or render the beach unsuitable for human use.

e. Aquatic Ecosystem and Organism Determinations

About 2 acres of intertidal habitat, containing mostly an impoverished sand assemblage with a small amount of productive rock assemblage, would be destroyed. One-half acre of productive subtidal habitat and organisms would be destroyed.

Except for the burial of about 0.5 acre of subtidal habitat and organisms, discharge of clean sandfill would not significantly disrupt the chemical, physical or biological integrity of the aquatic ecosystem below the mean low water line. The food chain would not be significantly disrupted in such a manner as to alter or decrease diversity of plant or animal species below the mean low water line.

No Federally listed threatened or endangered species would be impacted by the proposed discharge.

f. Proposed Disposal Site Determinations

A high degree of mixing would be expected nearshore as the project is located in a relatively open coastal location and is situated adjacent to the surf zone. Also, only coarse sand would be placed at the beach, and would be expected to remain there.

The placement of clean, coarse sand on the beach, construction of the groin and reconstruction of the revetment would not violate such water quality standards as are appropriate and applicable by law, as the only effect expected on the nearshore waters is a temporary minimal increase in suspended particulate and turbidity levels during construction.

Municipal and private water supplies would not be adversely affected by the proposed discharge.

Water-related recreation would be substantially improved by the proposed discharge, which would result in a recreationally inviting swimming beach at South End Beach.

The aesthetics at the beach would be temporarily degraded during construction, but the positive aspects of the resulting project would far outweigh this short-term effect. Temporary construction features would include the heavy equipment in use (trucks, bulldozers, crane), probably a staging area for heavy equipment, a construction office and piles of sand and stone.

No parks (other than the backshore park at South End Beach - a benefactor of the proposed discharge), national or historical monuments, national seashores, wilderness areas, research sites or similar preserves would be affected in any way by the proposed discharge.

g. Determination of Cumulative Effects on the Aquatic Ecosystem

There would be no cumulative effects on the aquatic ecosystem.

h. Determination of Secondary Effects on the Aquatic Ecosystem

There would be no secondary effects on the aquatic ecosystem.

FINDING OF COMPLIANCE
FOR
SOUTH END BEACH, ROCKLAND, MAINE
SMALL BEACH EROSION CONTROL PROJECT

1. No modifications of the Section 404(b)(1) guidelines have been made in preparation of this evaluation and supporting documents.

2. A detailed discussion of the rationale for selection of the proposed plan can be found in the main report. There is no practical or economical alternative to the proposed sandfill which would have less impacts on the aquatic ecosystem and be capable of achieving the basic purposes of the proposed project, which are restoration of a recreational beach area where one presently only minimally exists and protection of this beach, the city-owned backshore park and the backshore rail line against erosion. Shorter berm-widths would provide inadequate protection for the backland and inadequate recreational beach space; longer berm-widths would be environmentally less acceptable and provide more beach space than the projected usage would call for; groins alone would not be applicable at this beach due to the lack of littorally transported sand that could be trapped by them here; groins alone would not satisfy the recreational beach need; an offshore breakwater would not address the needed recreational beach improvement; rock revetment at the backshore would not protect the existing beach and not address the needed recreational beach improvement, consideration of the addition of a terminal groin at the northern end of the beach was deferred until after observing the fate of any placed sandfill; a southern groin was considered unnecessary due to the configuration of the beach; filling the southern beach portion to an extent similar to that on the northern beach portion, with no groin between the two was considered environmentally unacceptable; the "no action" alternative would leave the beach in an essentially minimally usable state, and would expose the backshore park facilities and adjacent rail line to increasing vulnerability to erosive processes.

3. The proposed discharge would not violate any applicable State water quality standards. The Toxic Effluent Standards of Section 307 of the Clean Water Act would not be violated.

4. The proposed discharge would not harm any species listed as threatened or endangered or their critical habitat under the Endangered Species Act of 1973. The proposed project is in compliance with the Marine Protection, Research and Sanctuaries Act of 1972. It is exempt from further testing, pursuant to the Ocean Dumping Regulations.

5. The proposed discharge would not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife and special aquatic sites. The life stages of aquatic life and other wildlife would not be significantly adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic and economic values would not occur.

6. Appropriate steps to minimize potential adverse impacts of the discharge on the aquatic ecosystem include the use of clean sand as the placed sandfill, being of appropriate grain size to minimize movement after placement, and the construction of a groin to protect the biologically productive rocky intertidal seaward section of the southern beach portion against sand movement from the northern beach portion.

7. On the basis of the guidelines, the proposed placement site for the sandfill is specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem.

Statement

The proposed site for the placement of sandfill material at South End Beach, Rockland, Maine has been specified through the application of the Section 404(b) Guidelines.

The project files and Federal regulations were reviewed to properly evaluate the objectives of Section 404(b) of Public Law 92-500, as amended. A public notice with respect to the 404 Evaluation will be issued. Based on information presented in this Section 404 Evaluation, I find the project would not result in unacceptable impacts to the environment.

Date

Thomas A. Rhen
Colonel, Corps of Engineers
Division Engineer

SUPPLEMENT - SOUTH END BEACH
BIOLOGICAL SAMPLING AND FIELD SURVEY RESULTS

I. Introduction

The purpose of this report is to summarize the results of a 4 April 1985 site visit to South End Beach. On this date, biological sampling was accomplished to provide input to the Environmental Assessment and 404 Evaluation processes for the proposed beach erosion control project.

II. Summary

Three sampling transects were established during the site visit at South End Beach on 4 April 1985. These transects ran in approximately an easterly direction from the shorelands of the beach out to approximately minus 3 to 4 feet MLW. A total of eight stations were examined for epifaunal and infaunal components. The dominant biological characteristic of the site was found to be the dense blue mussel (*Mytilus edulis*) beds, located in the lower intertidal zone at the northerly end and on the southerly portion of this beach.

III. Methodology

Sampling stations were established at 30 meter intervals along each transect. A 10-cm diameter core (volume equal to 1 liter) was taken at each station to characterize the benthic infauna. This sample was screened through a 0.5 mm sieve and preserved in 10 percent bufferred formalin. Two 20 cm by 20 cm square grids ($0.04m^2$) were placed one meter to each side of the infaunal core. These areas were examined for epifauna. After identification and enumeration of the epifaunal component, these same two grid areas (labeled A & B) were dug to a depth of 20 cm. All sediment was washed through a 1.0 mm screen, and the biological components were qualitatively described.

At all stations, any shellfish recovered were measured to the nearest millimeter.

IV. Field Observations

A. Transect I - Transect I was located on a 50° northeast vector from a marker established in the railroad tracks and labeled "RR #3" (see figure 3). The overall transect length was 90 meters with sampling stations at 30 meters, 60 meters, and 90 meters (Stations #1, #2 and #3, respectively).

Over the first 10 meters of the transect, a 4-meter high embankment slopes to the supratidal area of the beach. The 20 meter mark is approximately 1.5 meters below the high tide line. The substrate in this area is a fine to medium grain sand of mixed composition with abundant quartz and shell fragments. A wash line of various "seaweeds", *Fucus* sp., *Laminaria* sp., and *Ulva* sp., exists here, of approximately 1 meter width.

Station #1 (30 meters), consisted of a fine to medium grained sand substrate with glass and shell fragments, a few small cobbles and industrial debris (bricks, small cinders, etc.) present. This upper-intertidal area had no epifauna in either grid A or B. Laboratory analysis of the core sample revealed a benthic community of one species of polychaete worm (Capitella capitata) containing 14 individuals.

The 40-through 50-meter area had fine to medium grained sand substrate with cobbles present. This middle-intertidal area had a dense 1.5 cm surface covering of empty gastropod shells.

Station #2 (60 meters) had a medium to coarse grained sand substrate with abundant shell, rock fragments and industrial debris present. This lower intertidal area had only some unattached Laminaria sp. in its epifaunal grids. The benthic cores contained 53 individuals of Capitella capitata.

The 60- to 90-meter area was the transition zone between the lower intertidal and subtidal zones. The substrate was characterized by large boulders, muddy, sandy silt and dense blue mussel (Mytilus edulis) beds.

Station #3 (90 meters) was in the subtidal zone. Epifaunal grid A contained 112 blue mussels (Mytilus edulis), with an average length of 48.7 mm. One each of the polychaetes Pectinaria gouldii, Nephtys sp. and Polynoidia sp. were observed along with 68 gastropods of the species Littorina saxatilis. Epifaunal grid B contained 71 Mytilus edulis with a mean length of 56.5 mm. Two polychaetes were found, one Nereis sp. and one Polynoidia sp., along with 61 Littorina saxatilis.

The infaunal core contained 77 individuals of five species. The polychaete Capitella capitata dominated the sample, with 70 individuals, followed by 2 individuals each of the archiannelid Polygordius appendiculata, the gastropod, Littorina saxatilis and the bivalve, Mytilus edulis. One limpet, Acamea testudinalis was also recovered in the core.

B. Transect II - Transect II was located on a 60^{o} vector from the "RR #2" marker. The overall transect length was 78.1 meters with sampling stations at 30m, 60m, and 78.1m (stations #4, #5 and #6, respectively).

The first 20 meters of Transect II was on exposed wave-worn bedrock. The 30 meter mark was in the same fine to medium grained sand substrate with cobbles as found in station #1. Both eipfaunal grids were devoid of biota. The infaunal core contained 51 Capitella capitata, typical of the upper-intertidal zone of this beach.

The 40 meter mark was on a mid-intertidal zone bedrock outcrop. Two additional epifaunal grids sampled here recovered 5 Littorina saxatilis and one Mytilus edulis in A and 7 Littorina saxatilis and 2 Mytilus edulis in B, along with clumps of Fucus sp. The 50 meter mark was an area of medium to coarse grained sand with sparse cobbles.

Station #5 (60m) had a medium to coarse grained sand substrate devoid of epifauna. The infaunal core recovered 65 Capitella capitata and 1 Polygordius appendiculata.

The 70 meter through 80 meter areas were in the subtidal zone. Station #6 was sampled by epifaunal grids and infaunal core taken at 78.1 meters. Occasional boulders covered with Fucus sp. and Laminaria sp. were observed subtidally. Epifaunal grids were azoic. The infaunal core was representative of a typical sandy subtidal benthic community, having 8 species containing a total of 22 individuals. The three dominant organisms were Spio filicornis (6), Polygordius appendiculata (6) and Nephtys incisa (4), all annelids.

C. Transect III - Transect III was located on a 50° vector from the "RR #1" mark. The overall transect length was 60 meters with sampling stations at 30 and 60 meters (Stations #7 and #8, respectively).

The 10 meter mark was at the midslope of the shoreline embankment. The 20 meter mark, which was in the upper-intertidal zone, had a fine through coarse grained sand substrate covered with 2 centimeters of empty mussel and snail shells.

Station #7 (30 m) had a fine through coarse grained sand substrate and was located in the upper-intertidal zone. Epifaunal grids A and B contained no biota, but numerous shell fragments and small cobbles were present. The infaunal community contained 146 organisms, 143 of which were Capitella capitata and 3, Polygordius appendiculata.

The 40 meter mark had a shell and silty-sand substrate. At 44 meters, the mussel bed starts where the beach slope breaks to a low angle shelf, semi-protected by large boulders and rock outcrops.

Station #8 (60 meters) had a dense Mytilus edulis assemblage. Epifaunal grid A contained 63 Mytilus edulis (mean length=45.4mm), 3 Amphipoda, 6 Pectinaria gouldii and 82 Littorina saxatilis. Grid B contained 83 Mytilus edulis (mean length=43.1mm), 24 Pectinaria gouldii and 82 Littorina saxatilis. The infaunal core contained 372 Capitella capitata and 1 isopod, Jaera marina. At approximately the 77 meter mark (intertidal/ subtidal boundary), the mussel bed ended.

V. Summary Table

The attached table summarizes the composition of the benthic cores taken at Stations 1 through 8.

SUMMARY TABLE

Macrobenthic Invertebrates Found in Cores at Stations 1-8
South End Beach
Rockland, Maine
April 4, 1985

Station	Taxa/Species	# of Individuals
#1	Annelida/	
	Capitella capitata	14
#2	Annelida/	
	Capitella capitata	53
#3	Bivalvia/	
	Mytilus edulis	2
	Gastropoda/	
	Littorina saxatilis	2
	Acamea testudinalis	1
	Annelida/	
	Polygordius appendiculata	2
	Capitella capitata	70
	Total Station #3	77
#4	Annelida/	
	Capitella capitata	51
#5	Annelida/	
	Polygordius appendiculata	1
	Capitella capitata	65
	Total Station #5	66
#6	Gastropoda/	
	Littorina obtusa	1
	Annelida/	
	Polygordius appendiculata	6
	Harmothoe extenuata	1
	Nephtys incisa	4
	Capitella captitata	1
	Spiophanes bombyx	2
	Pygospio elegans	1
	Spio filicornis	6
	Total Station #6	22

#7	Annelida/	
	Polygordius appendiculata	3
	Capitella capitata	143
	Total Station #7	146
#8	Annelida/	
	Capitella capitata	372
	Isopoda/	
	Jaera marina	1
	Total Station #8	373

Note: Sampling was done by 1-liter hand core.

APPENDIX 1

PERTINENT CORRESPONDENCE

PERTINENT CORRESPONDENCE

TABLE OF CONTENTS

Rockland, City of Promise---Gateway of the Penobscot

City of Rockland, Maine 04841-0546

EXECUTIVE DEPARTMENT

July 8, 1986

Mr. Frank Fessenden
Army Corps of Engineers
Department of the Army
New England Division
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Fessenden:

The City Council of the City of Rockland has reviewed the South End Beach erosion study conducted by the Army Corps of Engineers. We approve of the preliminary plan and have included the local budget costs in the Capital Improvement Program. The City cannot make any commitment as to funding at this point in time but is interested in continuing cooperation between the Army Corps of Engineers and the City relative to the future potential beach development.

Thank you for your explanations and answers to my questions. Your on-site visit was especially helpful.

Please keep me informed of the progress on this matter.

Sincerely,

Cathy A. Smith
City Manager

CAS:ce

D. Killoy/559/jaa

July 18, 1985

Planning Division
Coastal Development Branch

Mr. William N. LaFlamme
Maine Dept. of Environmental Protection
Bureau of Land Quality Control
State House Station 17
Augusta, Maine 04333

Dear Mr. LaFlamme

This is in response to your letter of June 25, 1985 to David Killoy, Project Manager of South End Beach, Rockland, Maine. This letter expressed concerns with regard to sedimentation, erosion of fill impacting marine habitat and groin materials.

I am enclosing a brief report which addresses those concerns. These concerns will also be addressed in the final report.

Sincerely,

Joseph L. Ignazio
Chief, Planning Division

cc: J. Horowitz
CDB(3)

SOUTH END BEACH, ROCKLAND, MAINE
RESPONSES TO DEP CONCERNS OF 25 JUNE 1985

1. Will the project cause or contribute to sedimentation problems in the adjacent harbor?

<u>Response</u>: No. South End Beach is a pocket beach contained between the headlands of Atlantic Point on the south and the solid fill wharf on the north. The existing material is gravel and medium to coarse sand (see grain size analyses attached). Any proposed fill would be as coarse or more coarse than the existing beach material.

Using a method developed by Birkmeir (see A.S.C.E. Ports & Harbors Journal, May 1985)it was determined that the limiting depth for significant sediment transport was -4 mlw. This depth is within the cove formed by the two headland and therefore all fill material should remain in that area with no intrusion into the adjacent harbor.

These will of course be minor, transient turbidity during the construction but this also is anticipated to be localized near South End Beach.

2. Will erosion of sand fill result in harm to habitat of any marine resource?

<u>Response</u>: The project has been planned to minimize harm to marine resource habitat. Specifically it was recognized that the rocky intertidal area in the south portion of the project was of value. To prevent sandfill on the north portion of the beach from encroaching on this habitat a groin is proposed. To the south of the groin a much coarser grade of beach fill would be used. This would stand on a much steeper slope. This slope would "toe out" before reaching the productive area while still allowing dry beach area above.

The groin will utilize the existing out crops to the maximum extent and the remainder will be on relatively unproductive sand habitat. It is anticipated that the groin blocks and interstices will supply useful habitat. As indicated in item 1, little of the material would enter the harbor area.

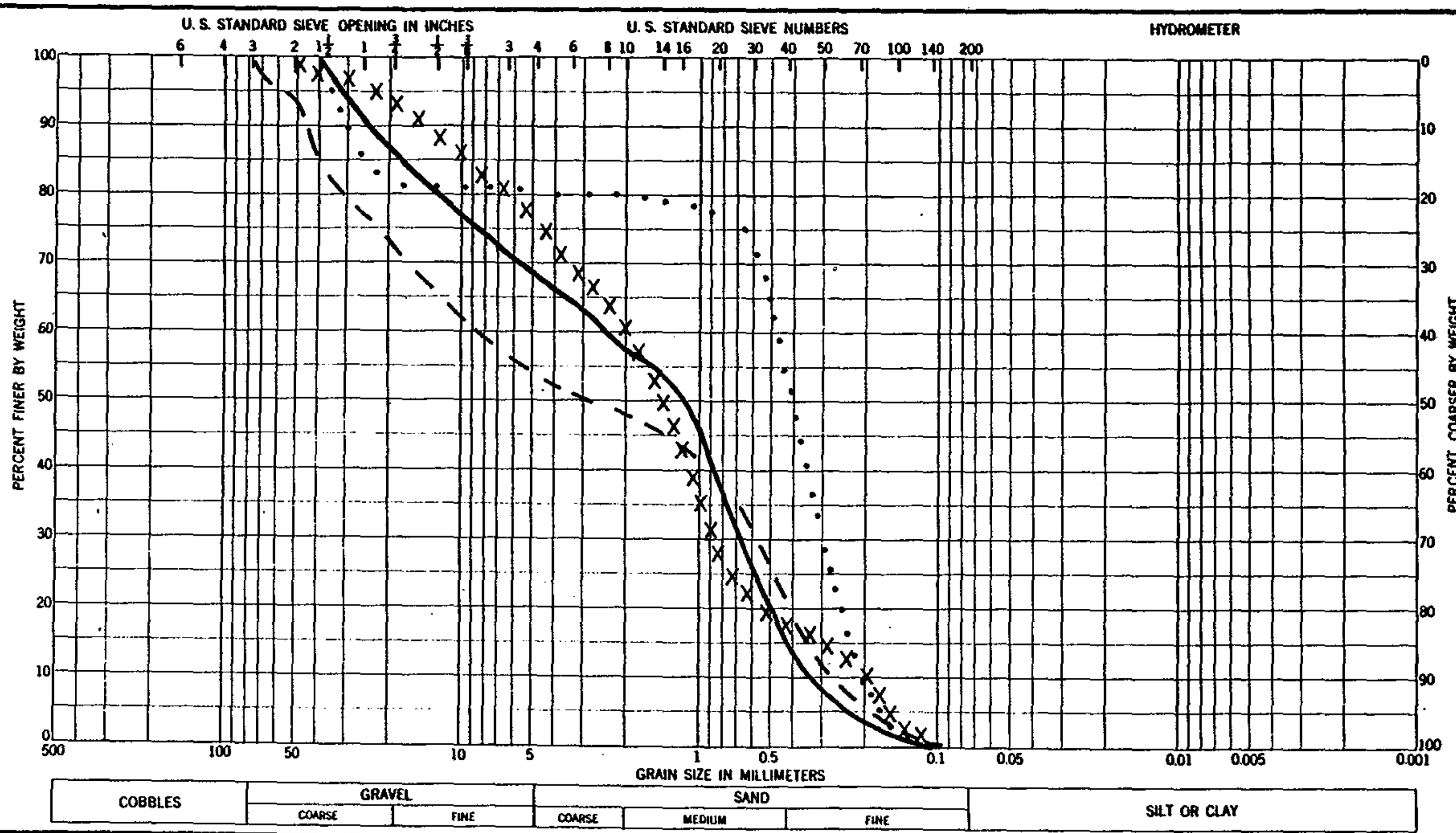
3. Can the proposed groin structure be constructed of material other than solid fill?

<u>Response</u>: The alternative to a rubble mound groin is a pile supported timber, steel or concrete sheeting structure. These require soil condition which will allow piles to be driven. Given the existing outcrops and anticipated shallow depth to bedrock we do not consider this feasible from an engineering and economic stand point.

The alternative structures also typically require more frequent maintenance than stone groins which would mean more periodic construction impacts. The proposed structure is designed to survive the 50 year project life with no maintenance.

The sheeting type structures also provide less area and less desirable surfaces for habitat.

David H. Killoy, P.E., C.P.G.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3 - 1	SURFACE	. . . .				
3 - 2	SURFACE	— — — — — — —				
3 - 3	SURFACE	————————				
3 - 4	SURFACE	XXXXXXXXXX				

Project SOUTH END BEACH
EROSION STUDY

Area ROCKLAND, MAINE

Boring No. COMBINED GRAIN SIZE ANALYSES

Date

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 15

6

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Services Division
Habitat Conservation Branch
14 Elm Street
Gloucester, MA 01930-3977

July 1, 1985

Mr. Joseph L. Ignazio
Chief, Planning Division
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Mr. Ignazio:

This is in response to your letter dated June 5, 1985, requesting a list of endangered or threatened species present in the area of the South End Beach, Rockland, Maine pursuant to Section 7(c) of the Endangered Species Act of 1973, as amended. We have identified the presence of no endangered or threatened species in the project area that come under the jurisdiction of the National Marine Fisheries Service. Should project plans change, or additional information on listed or proposed species become available, this determination may be reconsidered.

Sincerely,

Douglas W. Beach
Wildlife Biologist

STATE OF MAINE
Department of Environmental Protection

MAIN OFFICE: RAY BUILDING, HOSPITAL STREET, AUGUSTA
MAIL ADDRESS: State House Station 17, Augusta, 04333

JOSEPH E. BRENNAN
GOVERNOR

HENRY E. WARREN
COMMISSIONER

June 25, 1985

Dave Killoy, NEDPL-C
Project Manager
U.S. Army Corps
424 Trapelo Road
Waltham, Mass. 02154

RE: South End Beach, Rockland

Dear Dave:

I apologize for not getting this letter out to you sooner but I have been quite busy with a number of major projects which have taken up most of my time.

From reviewing the Department's regulations adopted pursuant to the Alterations of Coastal Wetland Act (Title 38 M.R.S.A.) as they apply to the proposed South End Beach project, and from speaking with Joe Kelley of the Maine Geological Survey concerning the project, it appears to be a viable proposal. However, if I am to recommend that concurrance with a consistency determination be made by the Board of Environmental Protection and a Water Quality Certification issued, several concerns will have to be addressed in the application and backed up with some scientific justification. These are as follows:

1. Whether the project will cause or contribute to sedimentation problems in the adjacent harbor.

2. Whether erosion of sand fill from the project will result in harm to habitat of any marine resource.

3. Whether the proposed groin/breakwater structure can be constructed of material other then solid fill.

For your convenience, I have enclosed an application for a consistency determination concurrance and Water Quality Certification in the event that you have not already been provided with such a form. Good luck with the project and I'll be looking forward to working with you in the future. Please feel free to call me at (207) 289-2111 if your have any questions.

Sincerely,

William N. Laflamme

WILLIAM N. LAFLAMME
Division of Licensing & Review
Bureau of Land Quality Control

WNL/bh

cc: John Delvecchio, S.P.O.

REGIONAL OFFICES
• Portland • • Bangor • • Presque Isle •

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. BOX 1518
CONCORD, NEW HAMPSHIRE 03301

Mr. Joseph L. Ignazio
Chief, Planning Division
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

JUN 17 1985

Dear Mr. Ignazio:

This responds to your June 5, 1985 request for information on the presence of Federally listed and proposed endangered or threatened species in conjunction with your Section 103 Beach Erosion Control Study at South End Beach in Rockland, Maine.

Our review shows that except for occasional transient individuals, no Federally listed or proposed species under our jurisdiction are known to exist in the project impact area. Therefore, no Biological Assessment or further consultation is required with us under Section 7 of the Endangered Species Act. Should project plans change, or if additional information on listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to endangered species under our jurisdiction. It does not address other legistation or our concerns under the Fish and Wildlife Coordination Act.

A list of Federally designated endangered and threatened species in Maine is enclosed for your information. Thank you for your cooperation and please contact us if we can be of further assistance.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor
New England Area

Enclosure

FEDERALLY LISTED ENDANGERED AND THREATENED SPECIES
IN MAINE

Common Name	Scientific Name	Status	Distribution
FISHES:			
Sturgeon, shortnose*	Acipenser brevirostrum	E	Kennebec River and Atlantic Coastal waters
REPTILES:			
Turtle, leatherback*	Dermochelys coriacea	E	Oceanic summer resident
Turtle, loggerhead*	Caretta caretta	T	Oceanic summer resident
Turtle, Atlantic ridley*	Lepidochelys kempii	E	Oceanic summer resident
BIRDS:			
Eagle, bald	Haliaeetus leucocephalus	E	Entire state - nesting habitat
Falcon, American peregrine	Falco peregrinus anatum	E	Entire state - re-establishment to former breeding range in progress
Falcon, Arctic peregrine	Falco peregrinus tundrius	E	Entire state Migratory - no nesting
MAMMALS:			
Cougar, eastern	Felis concolor cougar	E	Entire state - may be extinct
Whale, blue*	Balaenoptera musculus	E	Oceanic
Whale, finback*	Balaenoptera physalus	E	Oceanic
Whale, humpback*	Megaptera novaeangliae	E	Oceanic
Whale, right*	Eubalaena spp. (all species)	E	Oceanic
Whale, sei*	Balaenoptera borealis	E	Oceanic
Whale, sperm*	Physeter catodon	E	Oceanic
MOLLUSKS:			
NONE			
PLANTS:			
Small Whorled Pogonia	Isotria meleoloides	E	Kennebec, Cumberland, Oxford Counties
Lousewort, Furbish's	Pedicularis furbishiae	E	Aroostook County

* Except for sea turtle nesting habitat, principal responsibility for these species is vested with the National Marine Fisheries Service

Rev. 11/1/82

Mr. Killoy
1-4-5 C

HOROWITZ/et/518

~~May 30~~, June 5 1985

Planning Division
Impact Analysis Branch

Mr. Gordon E. Beckett, Supervisor
U.S. Department of the Interior
Fish and Wildlife Service
Ecological Services
P.O. Box 1518
Concord, New Hampshire 03301

Dear Mr. Beckett:

We are presently conducting a Section 103 Beach Erosion Control Study at South End Beach, in Rockland, Maine. The purpose of this letter is to request a list of endangered or threatened species for the project area, pursuant to Section 7(c) of the Endangered Species Act of 1973, as amended. The proposed project would involve the placement of sandfill on the beach and the possible construction of one or two groins.

If you require any further information about the proposed project or the affected area please contact Joseph Horowitz of the Impact Analysis Branch at FTS 839-7518.

Sincerely,

Joseph L. Ignazio
Chief, Planning Division

cc:
Mr. Horowitz
Mr. Killoy ✓
Mr. Bellmer
Mr. Pronovost
Plng Div File
Reading File

HOROWITZ/et/518

~~May 30~~ June 5, 1985

Planning Division
Impact Analysis Branch

Mr. Douglas Beach
National Marine Fisheries Service
Habitat Protection Branch
14 Elm Street
Gloucester, Massachusetts 01930

Dear Mr. Beach:

We are presently conducting a Section 103 Beach Erosion Control Study at South End Beach, in Rockland, Maine. The purpose of this letter is to request a list of endangered or threatened species for the project area, pursuant to Section 7(c) of the Endangered Species Act of 1973, as amended. The proposed project would involve the placement of sandfill on the beach and the possible construction of one or two groins.

If you require any further information about the proposed project or the affected area please contact Joseph Horowitz of the Impact Analysis Branch at FTS 839-7518.

Sincerely,

Joseph L. Ignazio
Chief, Planning Division

cc:
Mr. Horowitz
Mr. Killoy
Mr. Bellmer
Mr. Pronovost
Plng Div File
Reading File

JOSEPH E. BRENNAN
GOVERNOR

STATE OF MAINE
DEPARTMENT OF CONSERVATION
STATE HOUSE STATION 22
AUGUSTA, MAINE 04333

RICHARD B. ANDERSON
COMMISSIONER

June 1, 1985

Mr. Joseph L. Ignazio, Chief
Planning Division
U.S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02254

Dear Mr. Ignazio:

I have spoken with Joe Horowitz and generally reviewed the Army's plans for beach restoration in Rockland, Maine. Inasmuch as the location is a low energy beach today, I see no conflict with your plans for nourishment and Maine's laws.

Please let me know if I can be of further service to you.

Sincerely,

Joseph T. Kelley

Joseph T. Kelley, Director
Marine Geology Division

/cs

cc: Walter A. Anderson
State Geologist

MAINE GEOLOGICAL SURVEY - WALTER A. ANDERSON, STATE GEOLOGIST - TELEPHONE 207-289-2801

Rec'd 6-19-85

6-3-85

STATE OF MAINE
EXECUTIVE DEPARTMENT
STATE PLANNING OFFICE

JOSEPH E. BRENNAN
GOVERNOR

RICHARD E. BARRINGER
DIRECTOR

May 30, 1985

David Killoy NEDPL-C
Project Manager
U.S. Army Corps
424 Trapelo Road
Waltham, MA 02154

Dear David,

This letter is to give you preliminary comments on your conceptual proposal for nourishment of South End Beach in Rockland. I have talked to Bill LaFlamme and Teco Brown at the Department of Environmental Protection, Joseph Kelley at the Maine Geological Survey, and Harold Parks, Rockland City Manager. Everyone's comments have been generally positive, and I am aware of no major concerns at this time.

You should be sure to get preliminary comments from the Maine Geological Survey, the Departments of Environmental Protection and Marine Resources, and the City Planning Board. I also strongly recommend that you hold a public meeting in Rockland early in the design stage to assure your proposal is compatible with local residents and interested agencies.

Similar to the Belfast beach proposal, three Coastal Program core laws apply to the Rockland project: Alteration of Coastal Wetlands, Protection and Improvement of Waters and Municipal Shoreland Zoning.

Good luck with your project and please keep me informed as planning progresses.

Sincerely,

Jane Hird
for John DelVecchio
Local Grants Coordinator

JD:ld

184 STATE STREET, STATE HOUSE STATION 38, AUGUSTA, MAINE 04333 TEL. (207) 289-3261 or 3154

Rec'd 6-3-85

SPENCER APOLLONIO, COMMISSIONER

AREA CODE (207)
289-2291

Rec'd 5-24-85
D-K

STATE OF MAINE
DEPARTMENT OF MARINE RESOURCES
STATE HOUSE — STATION 21
AUGUSTA, MAINE 04333

May 17, 1985

Joseph Horowitz
Planning Division
Impact Analysis Branch
New England Division, Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Mr. Horowitz:

This is to respond to the proposed alternatives for development of the South End Beach in Rockland as outlined by David Killoy in the meeting on April 17, 1985 at the Rockland City Hall.

The existing area is dominated by a coarse sand beach over 400 feet wide with a narrow beach existing between the steep bank and the high tide line; this restricted area presumably limits the utility of the area for recreational purposes. There is a narrow region of boulders at the base of granite wall on the northwest end of the beach. The southeast end of the beach is marked by a ledge without significant vegetation extending from the upper beach to almost the same low tide level as the beach. A small, approximately 50 foot square, sandy area exists between the ledge and a larger ledge point extending approximately 200 feet northeast from main beach area and marking the natural maximum extent of the project area. The coarse, well drained sand of the main beach appears to contain no apparent significant infauna. The smaller isolated sand patch on the east has a coarse gravel that provides substrate for mussels and retains moisture at low tide which provides habitat for a variety of infauna principally polychaetes. I do not know the nature of the subtidal area immediately adjacent to the beach that would be affected by filling in the project, but since the low intertidal shore is sand I would expect the near shore subtidal area to be sandy also.

Three of the proposed alternatives involve adding sand to the main beach area to extend the top of the beach 25, 50 or 75 feet from the present and the present low waterline from 60 to 200 feet out from the present. These alternatives would have no significant change on the intertidal habitat but would displace the subtidal habitat to the extent mentioned and have a short-term impact to the toe of the fill until the area is recolonized.

Three other alternatives include extending the fill options to the southeast extreme ledge. The water retaining intertidal area would be replaced by sand that would probably drain well and would either have little to no infauna or if there is initially a diversity of particle size, could be colonized by soft clams and other forms.

The water quality of Rockland Harbor varies with the proximity to contaminated runoff streams but currently does not allow harvesting of shellfish by licensed harvesters for depuration and it is unlikely that it will reach levels permitting general shellfish harvesting in the foreseeable future. Habitat alteration would have no significant impact on shellfisheries.

The ledge outcrops are not appreciably colonized by algae or faunal forms. Covering these with sand would have no significant impact on present populations.

Killroy mentioned the possible desirability of erecting a granite structure at the northwest end of the beach. This type of structure would provide hard surface habitat that would essentially replace the existing hard surface habitat at that end of the beach,

In summary, the taking of subtidal area should be avoided or kept to a minimum as a matter of principle but we have not assessed the extent of the populations affected and do not believe that they are particularly significant. It would be desirable to retain the small moist intertidal area between the ledge outcrops because of its population diversity; its existance may be temporary however and the unconsolidated substrate could change at any time as the result of particularly strong waves or nourishment from the beach enlargement.

Sincerely,

Walter S.Foster
Area Biologist

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Management Division
Habitat Conservation Branch
14 Elm Street
Gloucester, MA 01930

May 17, 1985 F/NER74:SMR

Rec'd 5-23-85
D-K

Mr. Joseph L. Ignazio
Chief, Planning Division
Impact Analysis Branch
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Dear Mr. Ignazio:

This is in reference to your study concerning beach improvements for South End Beach, Rockland, Maine. Preliminary plans call for beach widening, to a level berm width of 25, 50, or 75 feet, by direct placement of sandfill over all or a portion of the approximately 450 feet of shoreline. Alternatives being considered include the placement of groin structures at the northern and southern beach limits.

The beach is divided into a public area about 350 feet long and a private area about 100 feet long. The public beach area is predominantly coarse-grained sand. Based on a Maine Department of Marine Resources' survey, this area supports a very limited biological community (sampling revealed no worms, shellfish, or amphipods). The private beach area consists of numerous rock outcroppings and muddy substrate; this area supports many benthic invertebrates, such as barnacles, blue mussels, periwinkles, marine worms, and amphipods, and dense stands of seaweeds.

Based on our site investigation and the information provided, we recommend that sand be placed only on the public beach area. We concur with your recommendation that a groin structure be placed at the boundary of the private/public beach to prevent placed sand from entering the private beach area. We would prefer that the berm width for the created beach be maintained at 25 feet to limit the additional fill encroachment in the subtidal zone associated with larger berm widths.

Impacts to aquatic resources from this beach nourishment project should be temporary, provided that frequent maintenance is not necessary. We would be interested in receiving monitoring information on this project as it becomes available.

For further coordination regarding this project, please contact Susan Mello Roe at 837-9270.

Sincerely,

Thomas E. Bigford

Thomas E. Bigford
Branch Chief

MAINE HISTORIC PRESERVATION COMMISSION
55 Capitol Street
State House Station 65
Augusta, Maine 04333

Earle G. Shettleworth, Jr.
Director

Telephone:
207-289-2133

May 16, 1985

Rec'd 5-21-8

Joseph L. Ignazio
Chief, Planning Division
Department of the Army
New England Division
Corps of Engineers.
424 Trapelo Road
Waltham, Massachusetts 02254

re: Proposed Beach Restoration of South End Beach, Rockland, Maine

Dear Mr. Ignazio:

In response to your recent letter, I have reviewed the above noted project including the placement of sand and two groins, one in the middle of the beach and one at the south end.

I find that this project will have no effect upon any structure or site of historic, architectural, or archaeological significance as defined by the National Historic Preservation Act of 1966.

If I can be of further assistance concerning this matter, please do not hesitate to let me know.

Sincerely,

Earle G. Shettleworth, Jr.
State Historic Preservation Officer

EGS/slm

Rec'd dDB
4-4-85

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. BOX 1518
CONCORD, NEW HAMPSHIRE 03301

Colonel Carl B. Sciple
Division Engineer
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Colonel Sciple:

This Planning Aid letter is intended to aid your study planning efforts for the development of beach erosion control measures at South End Beach, Rockland, Maine. It has been prepared under authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; U.S.C. 661 et seq.).

We understand that your preliminary plans for improvement includes beach widening, to a level berm width of 25, 50 or 75 feet, by the direct placement of sandfill along approximately 450 feet of shoreline, with or without groin structures at various locations. The project area is bounded on the northern end by the Point Clyde Sardine Processing Plant (in ruins) and on the southern end by a prominent rock outcropping that extends from the backshore to below the mean low water line. Approximately 100 feet north of this southern boundry a much smaller outcropping of rock is visable at mean low water. This smaller rock outcroping is the approximate boundry line between public beach to the north and private beach to the south.

A field investigation of the project area was conducted on March 19, 1985, by personnel of the Maine Department of Marine Resources and this Service. The public beach area, approximately 350 feet, is predominantly coarse-gained sand. Broken pieces of glass were very abundant along this beach. Fourteen test pits dug in the intertidal area yielded no shellfish, amphipods or marine worms. We conclude that the intertidal area of the public beach is relatively unproductive from a biological viewpoint.

In contrast, the intertidal area of the private section is more of a muddy sand and had large outcroppings of rock and scattered cobble. The rock habitat supported a profusion of barnacles, blue mussels, common periwinkles, rockweed and knotted wrack. Test pits dug in the intertidal area, especially at the lower elevations, produced many marine worms and amphipods. No soft clams were taken. Our limited collection of species included Glycera dibranchiata, Spio setosa and Marinogammarus finmarchicus. We conclude that the intertidal area of this private beach is very productive and have placed it in Resource Category 2.

The subtidal area adjacent to these beaches was not sampled. However, visual inspection revealed a member of rock outcroppings off the beach that should prove attractive to marine life. The area is utilized by fishermen and the predominant fish species caught are Atlantic mackerel and pollack.

The project, as proposed, would result in the placement of a substantial amount of sandfill below the mean water line. Based on data obtained from the project engineer, and on the beach berm width selected, the sandfill would extend from 130 to 180 feet seaward of the current mean low water line. The potential loss of this subtidal habitat would be difficult to mitigate. However, this potential loss could be avoided by carefully sizing the dimensions of the sandfill so that it does not infringe upon the subtidal area.

Sandfill within the intertidal zone of the project area would still result in a significant loss of productive habitat associated with the private beach. Therefore, we recommend that the area of sandfill be limited to the intertidal zone of the public beach. Sandfill in this area would result in only minor adverse impacts to fish and wildlife resources. Benthic organisms occupying this sandfill site may be destroyed through burial, mechanical damage or other means but should reestablish within a few growing seasons. Placement of sand during the late fall to early spring period will reduce adverse impacts upon these organisms. The migration of a large amount of sand from the new beach to the subtidal area or the adjacent private beach could have an adverse impact upon benthic habitat.

In order to more accurately assess the impacts of alternative project plans, the following information will need to be developed during the beach erosion control planning process: (1) refined estimates of the dimensions of the sandfill and groins, especially in relation to the mean high water and mean low water lines, and (2) an analysis of the potential migration of sand from the beach to other areas.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor
New England Field Office

CC: Walter Foster, ME DMR
Chris Mantzaris, NMFS
EPA, ATT: Peter Holmes
RO/HR Reading File
WO/ES/FP

Plan 2 - This plan is similar to Plan 1 except that a north groin would be added to protect the north end of the beach.

Plan 3 - This plan is similar to Plan 1 except that there would be no protective groins. In time the southern rocky intertidal area would be covered by sand and become unproductive.

Tables 11 and 12 present respectively the characteristics and the costs of the three plans.

Table 11
South End Beach, Rockland, ME
Characteristics of Alternative Improvement Plans

Plans	Dry Beach Area (ft")	Capacity * (Visitors
1	68,450	1,141
2	62,075	1,035
3	74,550	1,243

*(Assuming each visitor is provided with 75 square feet of beach area, with a daily turnover rate of 1.25.

Table 12
South End Beach, Rockland, ME
Costs of Alternative Improvement Plans

Alternative Plan

1 - Sandfill - Single Groin - Riprap Repair

(1)	First Cost	$400,000	
(2)	Interest during construction (3 mo.)	3,000	
(3)	Investment Cost		$403,000
(4)	Interest plus amortization (8-5/8% @ 50 Yrs)	35,000	
(5)	Annual Maintenance	6,500	
(6)	Total Annual Costs		$41,500

2 - Sandfill - Two Groins - Riprap Repair

(1)	First Cost	$438,000	
(2)	Interest during construction (3 mo.)	3,000	
(3)	Investment Cost		$441,000
(4)	Interest plus amortization (8-5/8% @ 50 Yrs)	38,400	
(5)	Annual Maintenance	6,700	
(6)	Total Annual Costs		$45,100

APPENDIX 2
TIDAL HYDROLOGY

TABLE OF CONTENTS

TIDAL HYDROLOGY
EROSION CONTROL STUDY
SOUTH END BEACH
ROCKLAND, MAINE

1. GENERAL

The purpose of this appendix is to provide the coastal engineer with climatic and tidal hydrology information necessary for evaluation of erosion processes at South End Beach and for the design of proper corrective measures.

Wind generated waves are the principal agent of coastal erosion. Near shore currents generated by waves, winds, astronomical tides or riverine flow also play an essential role. The precise location of most active erosion is determined to a significant extent by the water level as averaged over many tide cycles and wave periods. Substantial variations in water level can be produced by astronomical tides and by storm surges caused by the combination of high onshore winds and low atmospheric pressure. Factors related to water level variations and the production of waves in the study area will be discussed in this appendix.

2. ASTRONOMICAL TIDES

a. Tide Range. At Rockland, tides are semidiurnal, with two high and two low waters occurring during each lunar day (approximately 24 hours 50 minutes). The resulting tide range is constantly varying in response to the relative positions of the earth, moon, and sun; the moon having the primary tide producing effect. Maximum tide ranges occur when the orbital cycles of these bodies are in phase. A complete sequence of tide ranges is approximately repeated over an interval of 19 years, which is known as a tidal epoch. The mean range of tide and the mean spring range of tide are 9.7 and 11.2 feet, respectively (see Figure 1). However, the maximum and minimum probable astronomic tide ranges have been estimated at about 14.8 and 4.8 feet, respectively, in studies by the Corps Coastal Engineering Research Center (CERC) (see Table 1). The variability of astronomical tide ranges is a significant factor in tidal flooding potential at Rockland. This is explained further in Section 5.

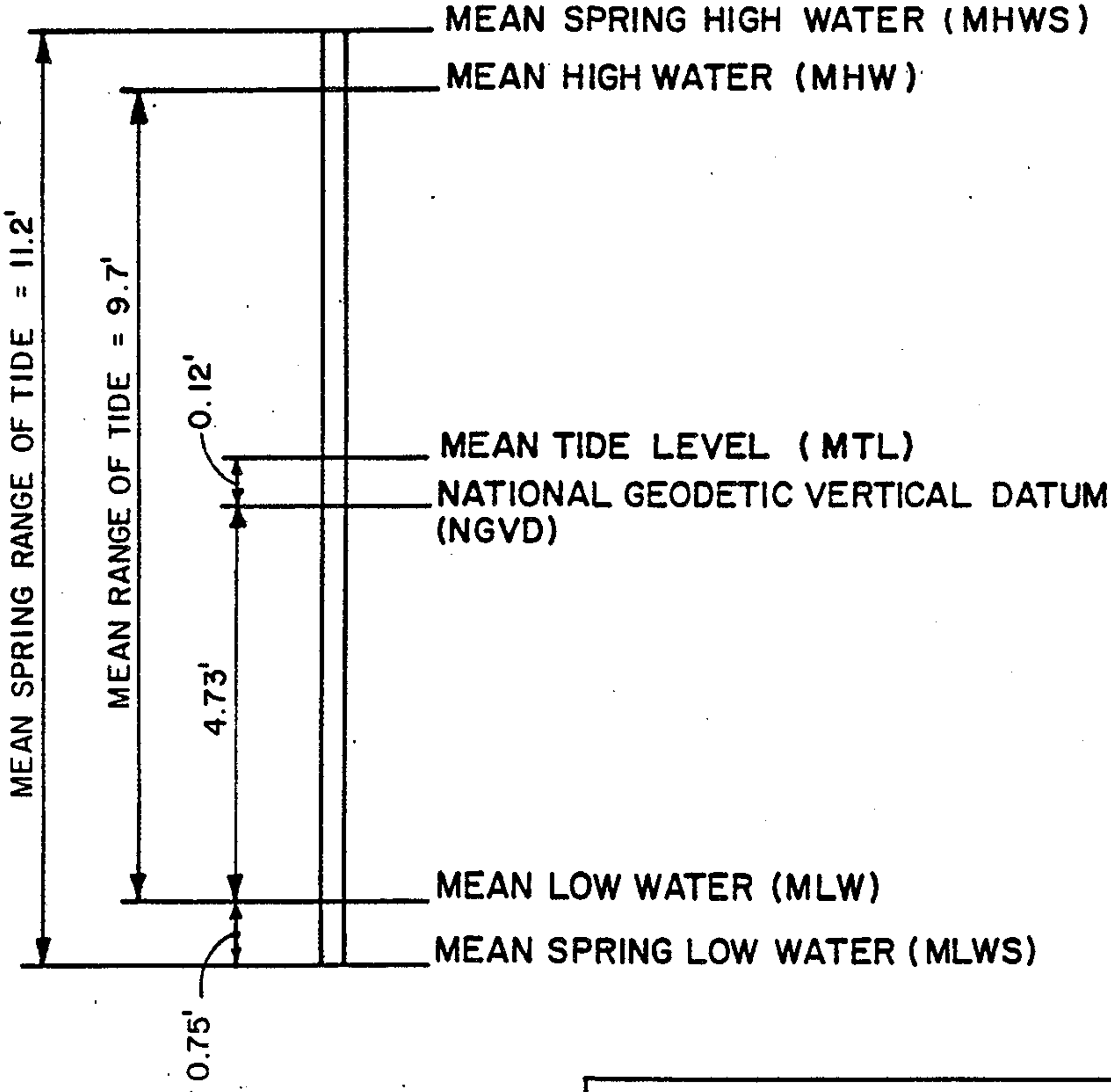
b. Tidal Datums. Because of the continual variation in water level due to the tides, several reference planes, called tidal datums, have been defined to serve as a reference zero for measuring elevations of both land and water. Tidal datum information for Rockland is presented on Figure 1 and Table 1. These data were compiled using currently available short term National Ocean Survey (NOS) tidal bench-mark data for Rockland along with the CERC report entitled: "Tides and Tidal Datums in the United States," SR No. 7, 1981.

FIGURE I

TIDAL DATUM PLANES

ROCKLAND, MAINE

(BASED UPON CURRENTLY AVAILABLE, SHORT TERM, NATIONAL OCEAN SURVEY TIDAL BENCHMARK DATA FROM 1960-78 TIDAL EPOCH)



NEW ENGLAND DIVISION
U.S. ARMY, CORPS OF ENGINEERS
WALTHAM, MASS. MAR. 1985

TABLE 1

ROCKLAND, MAINE
TIDAL DATUM PLANES
(From 1960-1978 Tidal Epoch)

	Tide Level (ft. NGVD)
Maximum Probable Astronomic High Water	7.5
Mean Spring High Water (MHWS)	5.7
Mean High Water (MHW)	5.0
Minimum Probable Astronomic High Water	2.4
Mean Tide Level (MTL)	0.1
National Geodetic Vertical Datum (NGVD)	0.0
Maximum Probable Astronomic Low Water	-2.4
Mean Low Water (MLW)	-4.7
Mean Spring Low Water (MLWS)	-5.5
Minimum Probable Astronomic Low Water	-7.3

c. Rising Sea Level. A phenomenon that has been observed through tide gaging and tidal benchmark measurements is that sea level is apparently rising with respect to the land along most of the U.S. coast. At Rockland, the rise is estimated to be slightly less than 0.1 foot per decade. Sea level determination is generally revised at intervals of about 25 years to account for the changing sea level phenomenon.

3. STORM TYPES

Two distinct types of storms, distinguished primarily by their place of origin as being either extratropical or tropical cyclones, influence coastal processes in New England. These storms can produce above normal water levels and must be recognized in studying New England coastal problems.

a. Extratropical Cyclones. These are the most frequently occurring variety of cyclones in New England. Low pressure centers frequently form or intensify along the boundary between a cold dry continental air mass and a warm moist marine air mass just off the coast of Georgia or the Carolinas and move northeastward more or less parallel to the coast. These storms derive their energy from the temperature contrast between cold and warm air masses. The organized circulation pattern associated with this type of storm may extend for 1,000 to 1,500 miles from the storm center.

The wind field in an extratropical cyclone is generally asymmetric with the highest winds in the northeastern quadrant. Since the storm center generally passes parallel and to the southeast of the New England coastline, highest onshore wind speeds are generally from the northeast. For this reason, these storms are called "northeasters" or "nor'easters" by New Englanders. As the storm passes, local wind directions may vary from southeast to slightly west of north. Coastline exposed to these winds can experience high waves and extreme storm surge. Such storms cause the highest tide levels and most frequent tidal flooding along the northern New England coastline. The prime season for northeasters in New England is November through April.

b. Tropical Cyclones. These storms form in a warm moist air mass over the Caribbean and the waters adjacent to the West Coast of Africa. The energy for the storm is provided by the latent heat of condensation. When the maximum windspeed in a tropical cyclone exceeds 75 mph, it is labeled a hurricane. Wind velocity at any position can be estimated based upon the distance from the storm center and the forward speed of the storm. The organized wind field may not extend more than 300 to 500 miles from the storm center. Recent hurricanes affecting New England generally have crossed Long Island Sound and proceeded landward in a generally northerly direction. However, hurricane tracks can be erratic. The storms lose much of their strength after landfall. For this reason the southern coast of New England experiences the greatest surge and wave action from the strong southerly to easterly flowing hurricane winds. However, on very rare occasions, reaches of coastline in northern New England may experience some storm surge and wave action from the weakened storm. The hurricane season in New England generally extends from August through October.

4. WINDS

An estimate of windspeed is one of the essential ingredients in any wave hindcasting effort. The most accurate estimate of winds at sea, which generate waves and propel them landward, is obtained by utilizing isobars of barometric pressure recorded during a given storm. However, actual recorded windspeed and direction data observed at a land-based coastal meteorological station can serve as a useful guide when more locally generated waves and currents are of interest. The disadvantage with using land-based wind records is that they may not be totally indicative of wind velocities at the sea-air interface where the waves are generated. However, often they are the only available source of information and adjustments must be made to develop overwater estimates from the land-based records.

The National Weather Service (NWS) recorded hourly observations of 1-minute average windspeed and direction at Portland International Jetport in Portland, Maine from 1948 through 1965. Portland is the closest location to the project for which relatively complete, systematically recorded, wind data are available.

These windspeed data were then adjusted to a standard 33-foot observation height and 1-minute average windspeeds were converted to 1-hour average windspeeds. Since Portland International Jetport is not directly adjacent to the ocean, a land-to-sea conversion was applied. Because all fetches of interest at South End Beach are less than 10 miles, an air-sea temperature difference adjustment was not applied. All adjustments were made in accordance with ETL 1110-2-305 on the subject of determining wave characteristics on sheltered waters. Utilizing these 1-hour average wind data, the percent occurrence of wind direction and windspeed range has been computed. Since only onshore winds at South End Beach are of interest, the wind directions utilized in this analysis have been limited to those between north (N) and southeast (SE). This analysis, the results of which are shown in Table 2 and Figure 1a, indicates that the principal onshore wind direction for windspeeds from 0 up to 25 mph is from N and, for windspeeds 25 mph or greater it is from the E. The maximum average windspeed (9.2 mph) is from the NNE and the greatest maximum speed was 49.2 mph from the ESE. Overall average speed is 8.4 mph. Table 2 also shows the resultant wind direction for various windspeed ranges. The resultant wind direction is a vector quantity computed using the product of windspeed and direction. It is an indicator of net air movement past a given location. Overall, the resultant wind direction is from the NE at the average resultant speed of 6.2 mph. The greatest percentage of windspeeds is shown to be in the 5 to 10 mph range.

Utilizing the above mentioned height adjusted data base, average windspeeds and resultant directions were computed over various durations with the other previously mentioned adjustments being made subsequently. Annual maximum values were then determined for each onshore direction. The frequency of these annual values has been determined using a Pearson Type III distribution function with expected probability adjustment. The systematic record alone was used for all analyses. In some cases severe hurricane or northeast storm winds were identified as high outliers in a statistical test and sometimes high skews were observed. These cause some inconsistency in the estimates. All results are summarized in Tables 3(a) through 3(g). To obtain estimates of windspeed-duration relationships for a particular return period and direction, it is recommended that a graphical curve fitting analysis employing engineering judgment be conducted using the tabularized values. Figure 2 is an example of this technique based on data from Table 3(e).

Additionally, windspeed persistence was determined on a directional basis. The resulting windspeed persistence data, for directions north through southeast, indicate the maximum number of consecutive hourly windspeed observations that occurred at or above a given speed from a particular direction.

TABLE 2

PORTLAND, MAINE
ADJUSTED HOURLY WIND OBSERVATIONS BETWEEN N AND SE
(One-Hour Average Values)

PERCENT OF ONSHORE WIND SPEED AND DIRECTION OBSERVATIONS (X 10)

Direction	Wind Speed Range (MPH) 0-5	5-10	10-15	15-20	20-25	25-30	Over 30	All Inclusive	Avg. Speed (mph)	Max. Speed (mph)
N	62	143	88	25	6	1	1	326	8.2	36.9
NNE	27	67	58	21	5	1	0	179	9.2	34.8
NE	20	44	26	8	3	1	0	102	8.3	33.8
ENE	15	38	26	8	4	2	1	94	9.1	33.8
E	22	57	41	10	4	2	1	137	8.8	46.1
ESE	19	41	26	4	2	0	0	92	8.0	49.2
SE	21	30	15	3	1	0	0	70	7.2	37.9
N-SE	185	422	280	79	24	7	3	1,000	8.4	49.2
Resultant Direction:	NE	NE	NE	NE	NE	ENE	ENE	NE		

NOTES: 1) Wind speed ranges indicated include values greater than or equal to the lower limit and less than the higher limit.

2) Onshore winds occur 28 percent of the time. Therefore, average annual number of occurrences (A) = percent occurrence times 24.545. For instance, for a wind speed range of 0-5 mph from the north, A = 6.2 (24.545) = 152.

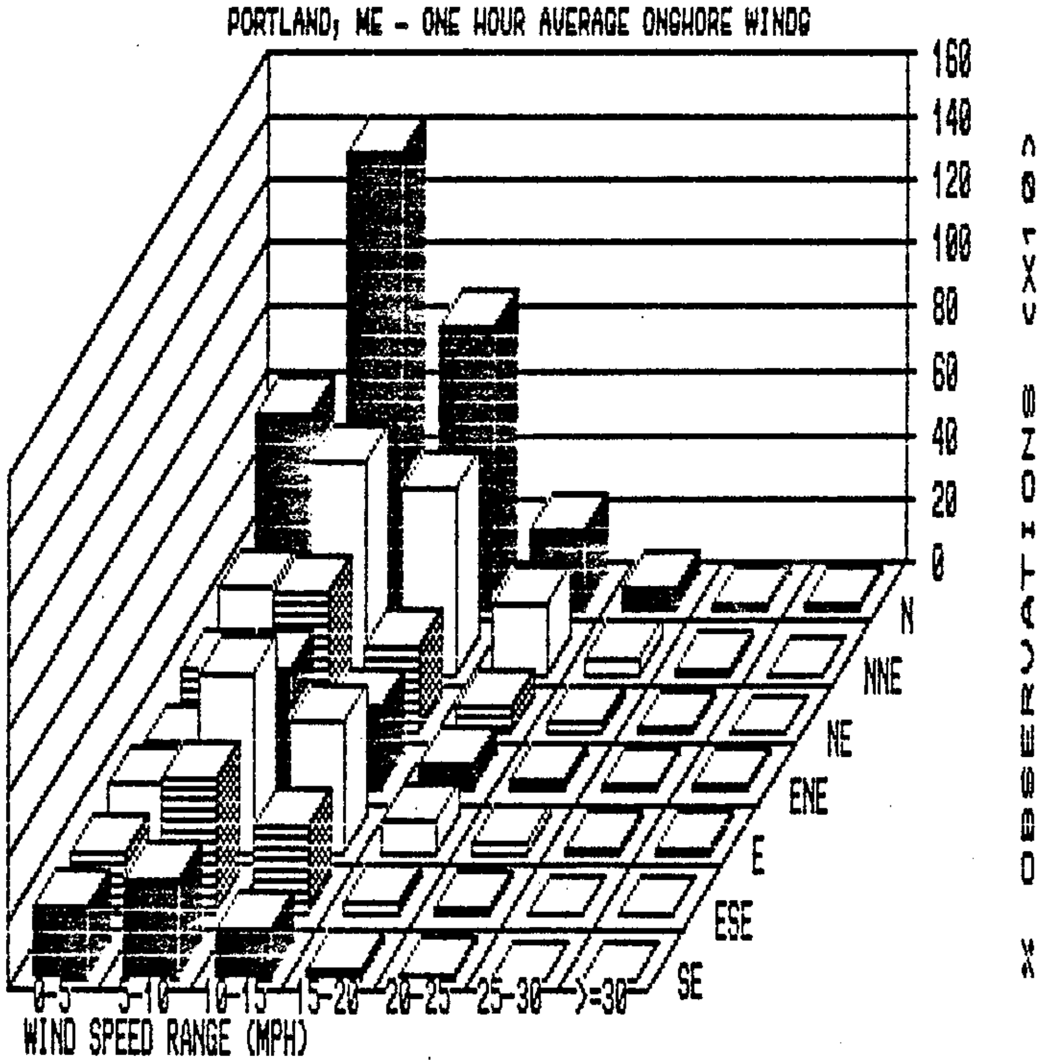

PORTLAND, ME - ONE HOUR AVERAGE ONSHORE WINDS
160
140
120
100
80
60
40
20
0
N
NNE
NE
ENE
E
ESE
SE
0-5
5-10
10-15
15-20
20-25
25-30
>=30
WIND SPEED RANGE (MPH)
OBSERVATIONS (X10)

FIGURE 1A

TABLE 3

FREQUENCY OF ADJUSTED ANNUAL MAXIMUM WIND SPEEDS (MPH)
PORTLAND, MAINE
(Based on 18 Years of Hourly Data Observations, 1948-1965)

(a)

Direction: N

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	20	31	37	41	47	51	55	0.9	N(0)
1	16	25	30	34	38	41	44	0.9	N(0)
2	14	23	27	30	33	36	38	0.6	N(0)
3	16	21	25	28	32	35	39	1.3	N(1)
4	14	21	25	28	31	34	37	1.1	N(1)
6	12	20	25	27	30	33	35	0.7	N(0)
8	13	19	23	26	30	33	36	1.3	N(1)
12	14	18	22	25	29	32	36	1.6	N(2)

(b)

Direction: NNE

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	22	28	33	36	41	44	48	1.3	N(1)
1	18	23	27	30	33	36	39	1.3	N(1)
2	15	21	25	28	31	34	36	0.9	N(1)
3	12	22	25	27	30	31	32	0.1	N(0)
4	12	21	24	26	29	30	32	0.4	N(1)
6	12	20	23	25	27	29	30	0.3	N(0)
8	11	20	22	24	25	26	27	-0.3	N(0)
12	9	17	20	22	24	25	27	0.2	N(0)

Legend: H = Hurricane

N = Northeaster

(1) = Number of high outliers identified by high outlier test

(c)

Direction: NE

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	17	28	34	37	41	45	48	0.7	N(0)
1	14	23	27	30	34	36	39	0.7	N(0)
2	10	21	25	27	29	31	33	0.1	N(0)
3	10	20	23	25	27	29	31	0.2	N(0)
4	9	18	23	25	28	30	32	0.4	N(0)
6	9	17	21	23	25	27	29	0.4	N(0)
8	8	16	19	21	24	26	28	0.5	N(0)
12	5	16	20	21	23	24	25	-0.2	N(0)

(d)

Direction: ENE

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	13	33	39	41	44	46	47	-0.4	N(0)
1	11	27	31	33	36	37	38	-0.4	N(0)
2	10	25	30	31	34	35	36	-0.4	N(0)
3	10	24	29	31	33	34	36	-0.3	N(0)
4	10	23	27	29	31	33	34	-0.2	N(0)
6	10	21	26	28	31	33	35	0.2	N(0)
8	9	20	24	27	29	31	33	0.1	N(0)
12	6	18	22	25	27	29	31	-0.0	N(0)

(e)

Direction: E

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	21	36	44	49	56	61	67	0.8	H(1)
1	17	29	36	40	45	49	53	0.8	H(1)
2	14	26	33	38	43	47	51	0.8	H(0)
3	14	24	31	36	43	48	53	1.2	H(1)
4	12	23	29	32	37	40	43	0.6	N(1)
6	10	21	26	30	33	36	39	0.5	N(1)
8	12	21	27	31	36	40	44	1.0	N(1)
12	5	17	22	25	28	31	33	0.3	N(0)

(f)

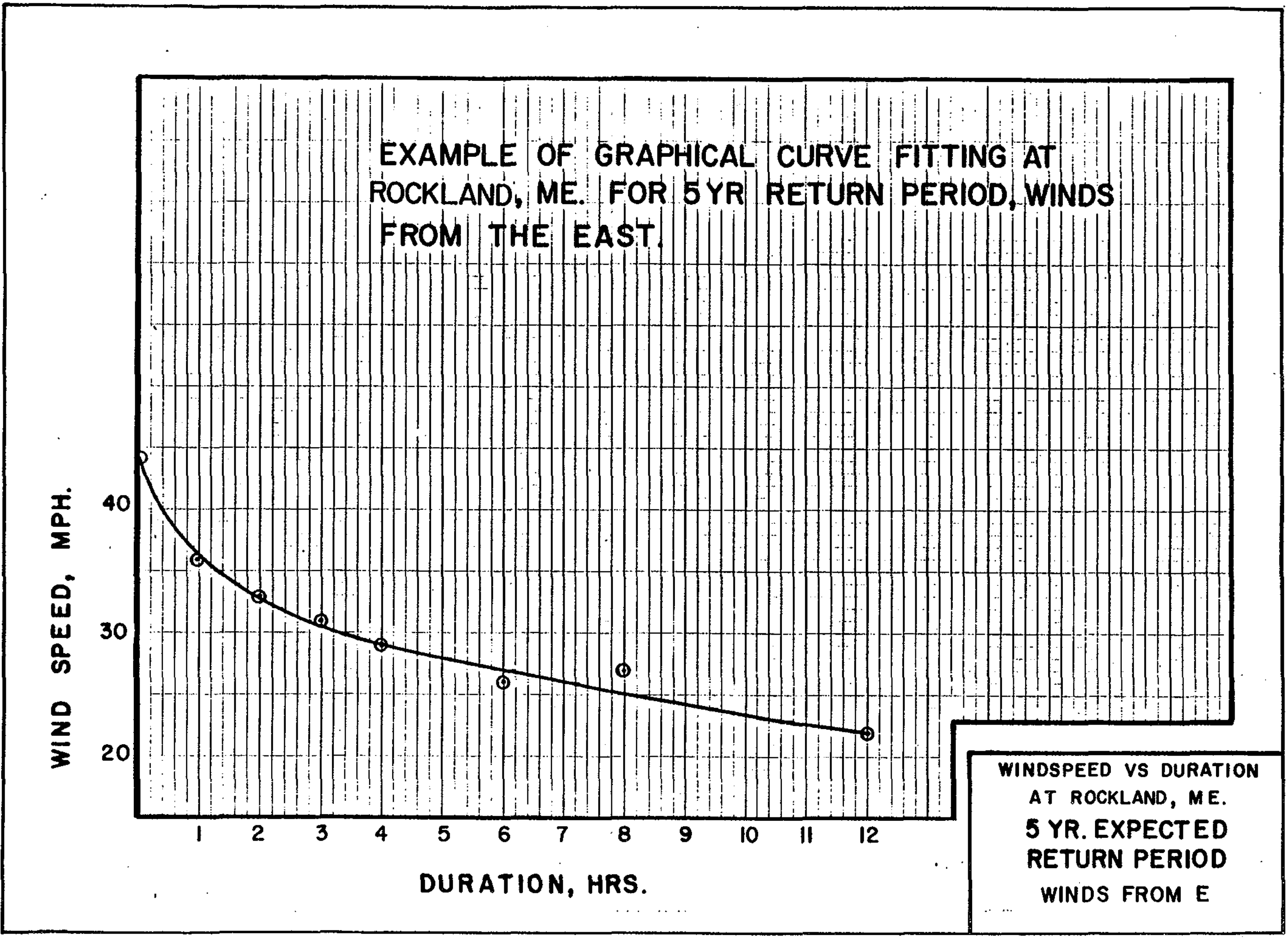
Direction: ESE

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	20	29	39	46	55	63	71	1.6	H(1)
1	16	24	31	37	45	51	57	1.6	H(1)
2	6	22	26	28	29	30	31	-0.7	N(0)
3	9	21	24	26	28	29	30	-0.4	N(0)
4	9	19	27	32	39	45	50	1.2	H(1)
6	8	18	24	28	33	36	40	0.9	H(1)
8	6	16	19	21	23	25	26	0.2	N(0)
12	4	15	20	23	26	28	30	0.4	H(0)

(g)

Direction: SE

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	10	29	38	44	50	55	60	0.6	H(0)
1	8	23	31	35	41	45	49	0.6	H(0)
2	8	22	30	35	41	45	50	0.8	H(0)
3	10	19	26	30	36	40	45	1.1	H(1)
4	7	18	24	28	33	37	41	0.8	N(1)
6	7	15	19	22	26	29	32	0.8	N(0)
8	6	17	23	28	33	38	42	1.0	N(1)
12	4	14	20	24	29	32	36	0.9	N(1)



EXAMPLE OF GRAPHICAL CURVE FITTING AT ROCKLAND, ME. FOR 5 YR RETURN PERIOD, WINDS FROM THE EAST.
WIND SPEED, MPH.
40
30
20
1
2
3
4
5
6
7
8
9
10
11
12
DURATION, HRS.
WINDSPEED VS DURATION
AT ROCKLAND, ME.
5 YR. EXPECTED
RETURN PERIOD
WINDS FROM E

FIGURE 2

The highest average windspeeds are 46 mph from the east and 49 mph from the east-southeast. All this information demonstrates that high onshore winds can occur for extended periods of time in the study area. Lower speed winds seem to come mainly from the northeast with an increasingly easterly trend as the speed class increases.

Waves generated during coastal storm are particularly potent as an erosive force. Therefore, it is useful to examine wind conditions occurring during past storms when estimating the severity of wave conditions. Table 4 presents National Weather Service wind observations recorded at Portland during days of storm induced tidal flooding. It can be seen that the strongest winds recorded on these dates generally occurred between north and east. The highest speed listed, 69 mph from the east-northeast, was recorded on 31 August 1954.

In addition, wind information for Portland compiled on a monthly basis for all directions has been published by Wright-Pierce and C. E. Maguire, Inc. in their April 1983 report regarding the Rockland Fish Pier. Table 4a and Figures 2A through 2C present their wind data obtained from the National Climatic Center from 1951 to 1973 and from the Pittston Oil Refinery Study from 1931 to 1948, respectively, which shows that at Portland, the average annual windspeed was 8.8 mph from the south, with a maximum "fastest mile" wind of 76 mph. Almost all winds above 60 mph were from the eastern quadrants. The strongest winds and gales occur during the winter when winds are generally from a northerly direction.

Short term Rockland wind data for the period June 1954 to May 1959 were also published by Wright-Pierce. Table 4b presents a windspeed direction summary for Rockland which shows winds were generally calm about 26 percent of the time. Winds were between 4 and 15 knots nearly 60 percent of the time, between 16 and 31 knots about 14 percent of the time and exceeded 31 knots less than 1 percent of the time. A wind rose for Rockland is shown in Figure 2D.

5. STORM TIDES AND TIDE STAGE FREQUENCY

a. General. The total effect of astronomical tide combined with storm surge produced by wind, wave, and atmospheric pressure contributions is reflected in actual tide gage measurements. Since the astronomical tide is so variable at the study area, the time of occurrence of the storm surge greatly affects the magnitude of the resulting tidal flood level. Obviously, a storm surge of 3 feet occurring at a low astronomic tide would not produce as high a water level as would be produced if it occurred at a higher tide. It is important to note that the storm surge itself varies with time, thus introducing another variable into the makeup of the total flood tide at any point in time.

TABLE 4

PORTLAND INTERNATIONAL JETPORT
NATIONAL WEATHER SERVICE
WIND OBSERVATIONS
DAYS OF MAXIMUM TIDAL FLOODS

Date	Resultant Direction	Resultant Speed (MPH)	Average Speed (MPH)	Fastest Mile Speed (MPH)	Fastest Mile Direction
7 Feb 78	NNE	21.4	22.0	29	NE
9 Jan 78	S	22.7	29.2	48	SE
16 Mar 76	NE	10.2	12.2	23	NE
30 Nov 44**					
20 Nov 45**					
6 Apr 58***	E*	--	13.8	38	NE
28 Dec 59***	NNE*	--	13.1	24	NE
19 Feb 72	NE	16.9	19.0	34	E
4 Mar 31**					
21 Apr 40**					
20 Jan 61	N*	--	22.2	35	N
5 Apr 77***	E	5.8	12.9	25	SE
2 Nov 63	N*	--	11.4	20	WSW
20 Nov 72	NNW	2.9	10.9	22	NE
4 Apr 73	ENE	7.4	9.9	25	SE
21 Dec 76	WNW	10.0	11.2	21	W
19 Nov 18**					
7 Dec 19**					
31 Aug 54	ENE*	--	23.6	69	E
21 Dec 60	SE*	--	15.0	40	SE
16 Apr 61	ENE*	--	17.5	31	NE
23 Dec 68	SSE	3.0	8.3	21	SE
14 Apr 72	N	10.3	11.5	17	NE
11 Dec 50	NNE*	--	8.4	21	NE
13 Apr 53	NNE*	--	13.7	27	N
25 Oct 53	NNE*	--	19.3	35	NE
11 Dec 69	S	11.2	18.0	31	S
17 Mar 72***	SE	6.3	7.9	24	SE
2 Dec 74	NNE	12.4	13.4	23	NE

*Resultant speed and direction not available for the period prior to 1964 therefore direction shown is prevailing wind direction.

**Wind data not available.

***Day prior to maximum tidal flood is shown as it is more indicative of storm conditions.

TABLE 4a

WIND INFORMATION FOR

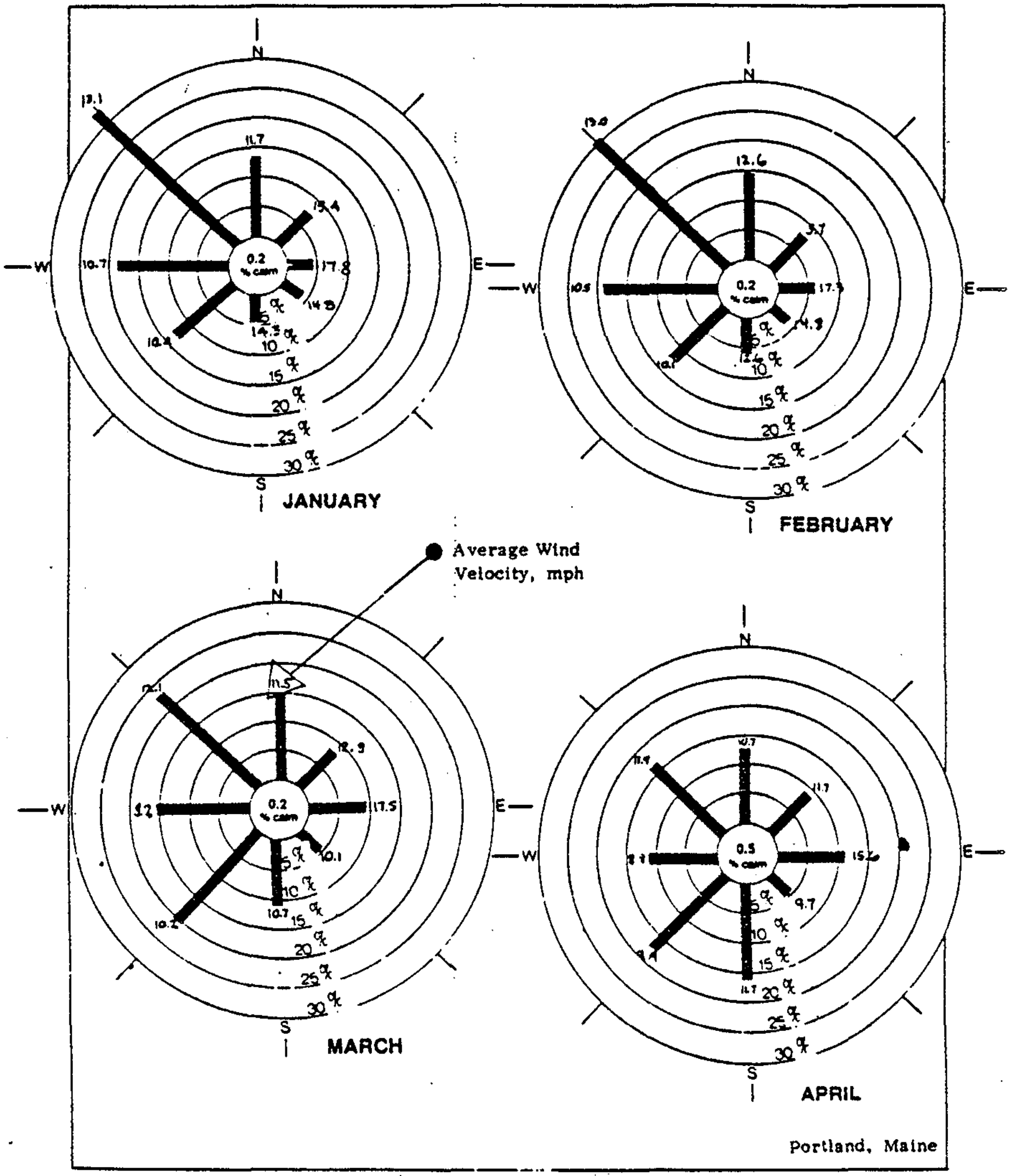
PORTLAND, MAINE

Month	Mean Speed	Prevailing Direction	Fastest Mile Speed	Direction	Year
January	9.2	N	50	SE	1951
February	9.6	N	58	N	1952
March	10.1	W	76	NE	1947
April	10.0	S	57	S	1946
May	9.2	S	49	NW	1950
June	8.2	S	45	SW	1969
July	7.7	S	44	W	1941
August	7.6	S	69	E	1954
September	7.8	S	62	SE	1960
October	8.5	N	45	N	1963
November	8.8	W	76	NE	1945
December	9.0	N	62	SE	1957
Annual	8.8	S			
Maximum			76	NE	Mar 1947

PERIOD OF RECORD: 1951 - 1973

Source: National Climatic Center
Asheville, North Carolina

WIND DURATION FREQUENCIES: JAN.-APRIL

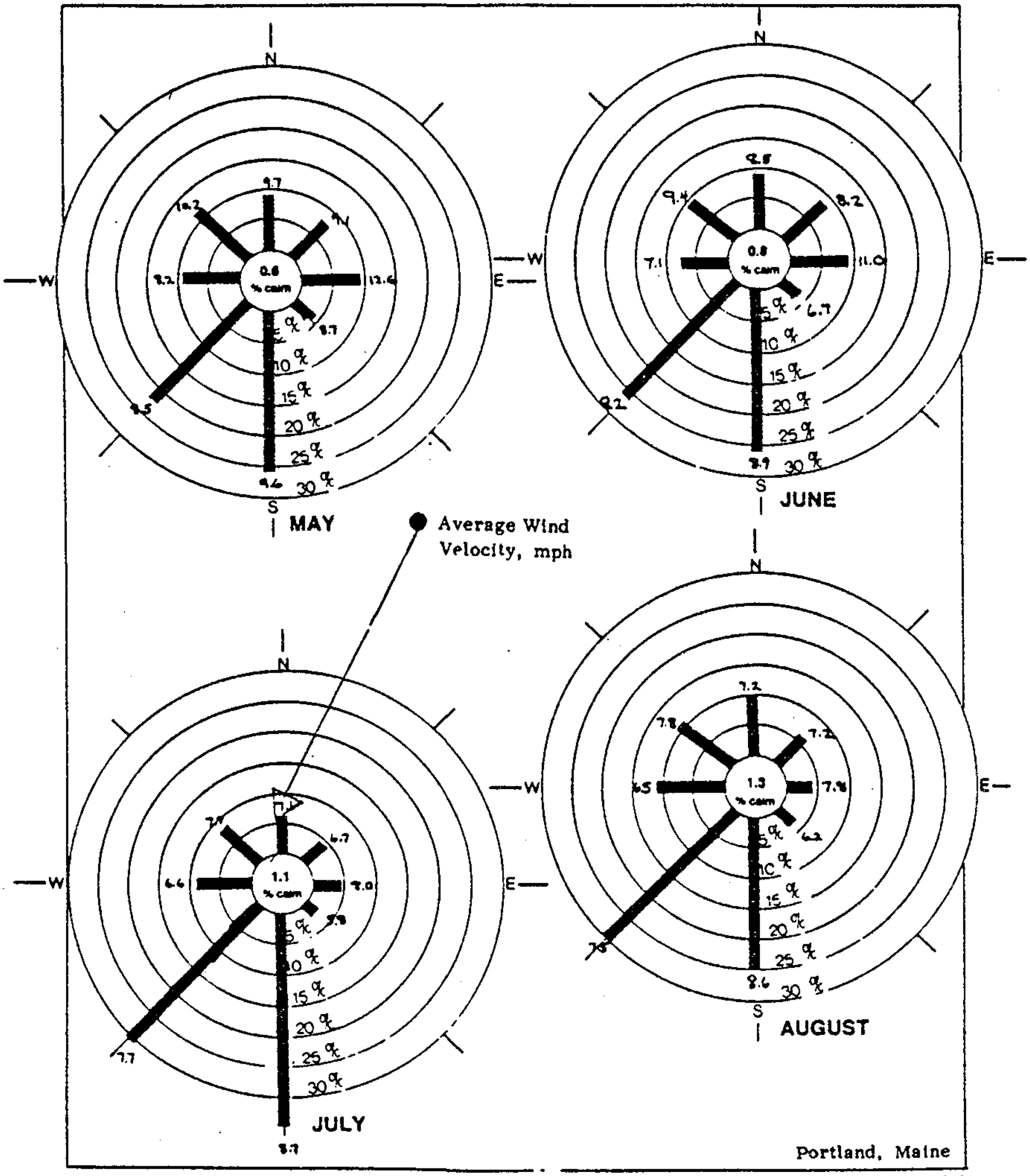


SOURCE: Final EIS
Pittston Oil Co.
1978

PERIOD OF RECORD 1931-1948

FIGURE 2A

WIND DURATION FREQUENCIES: MAY-AUG.

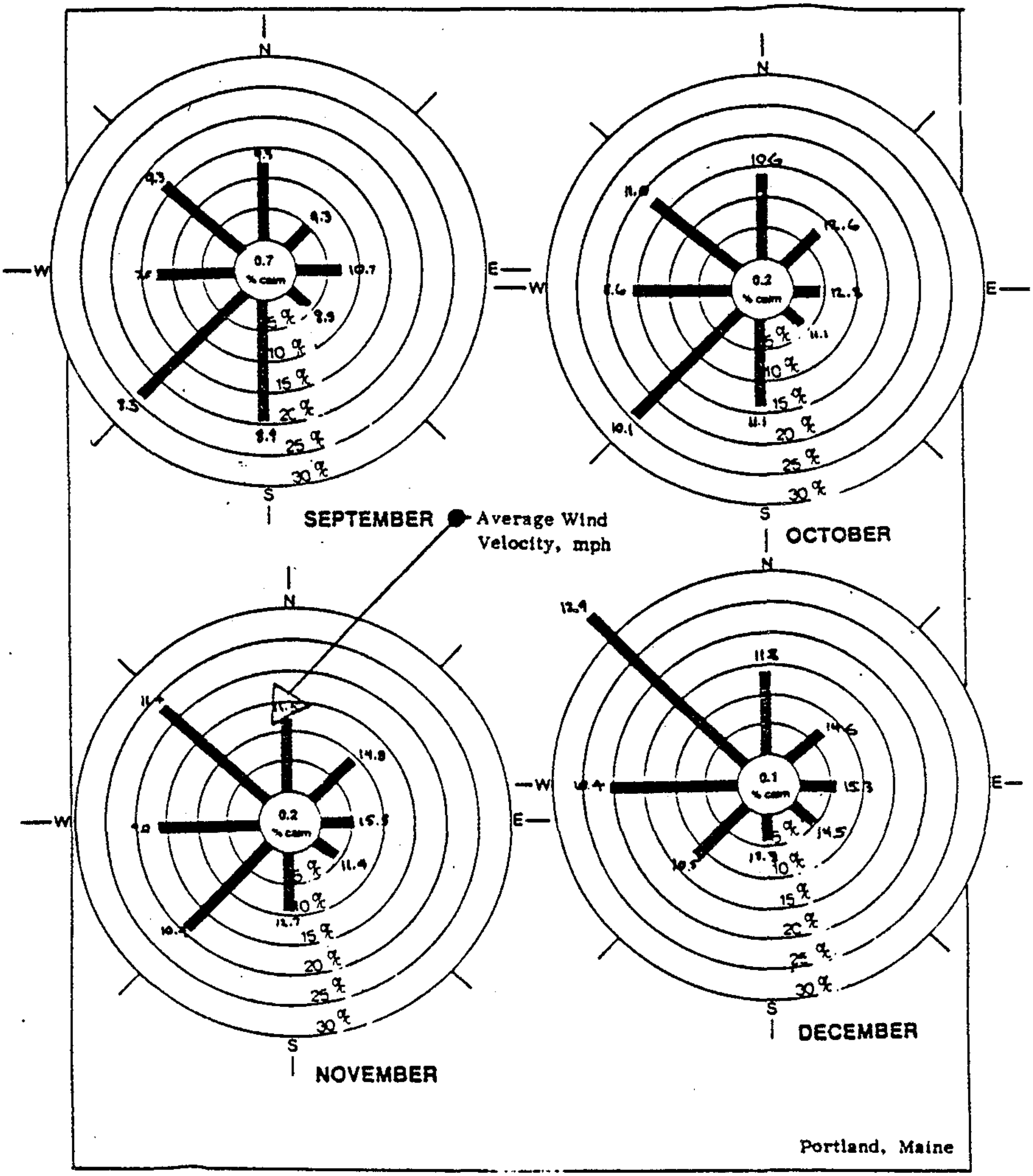


PERIOD OF RECORD 1931-1948

SOURCE: Final EIS
Pittston Oil Co.
1978

FIGURE 2B

WIND DURATION FREQUENCIES: SEPT.-DEC.



SOURCE: Final EIS
Pittston Oil Co.
1978

PERIOD OF RECORD 1931-1948

FIGURE 2C

TABLE 4b

WIND DIRECTION VERSUS WIND SPEED

ROCKLAND, MAINE

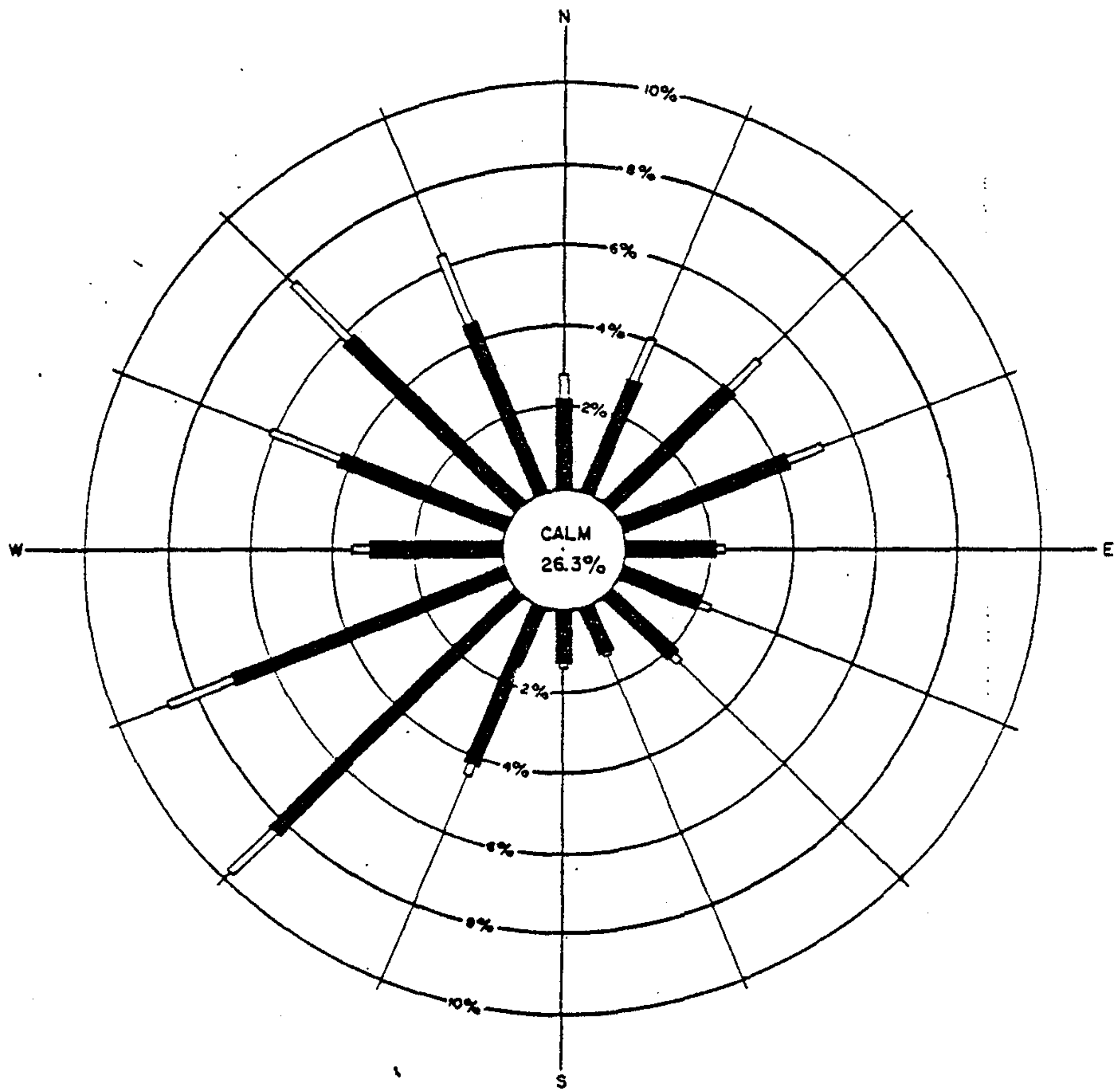
DIRECTION	SPEED GROUPS (MPH)								PERCENT
	0-3	4-12	13-15	16-18	19-24	25-31	32-37	38 & Gr.	
N	0.3	1.8	0.4	0.4	0.2	+			3.1
NNE	0.4	2.5	0.5	0.7	0.3	0.1			4.4
NE	0.5	3.3	0.8	0.7	0.3	+			5.7
ENE	0.7	3.6	0.7	0.6	0.3	+		+	5.9
E	0.7	1.9	0.2	0.1	0.1	+			3.1
ESE	0.6	1.8	0.2	0.2	0.1	+			3.0
SE	0.8	2.1	0.1	0.1	0.1	+			3.2
SSE	0.4	1.1	0.1	0.1	+	+			1.7
S	0.5	1.2	0.1	0.1	+			+	1.9
SSW	0.8	3.7	0.5	0.2	0.1	+			5.2
SW	1.3	6.9	1.4	1.0	0.4	0.1	+		1.11
WSW	1.0	5.5	1.5	1.0	0.6	0.1			9.6
W	1.0	2.6	0.5	0.3	0.1	+			4.5
WNW	0.7	3.6	0.7	1.1	0.6	0.1	+		6.9
NW	0.8	4.6	1.2	1.2	0.6	0.1	+		8.6
NNW	0.5	3.5	1.0	1.2	0.5	0.1	+		6.8
Calm	15.3								15.3
Percent	26.3	49.8	9.9	9.0	4.4	0.6	+	+	100.0

+ Less than 0.05 percent.

Period of Record: June 1954 - May 1959*

Source: National Climatic Center
Asheville, North Carolina

* February 1958 Missing, February 1960 substituted.



4 — 15 KNOTS
16 — 31 KNOTS
0 — 3 KNOTS = CALM

ROCKLAND FISH PIER

WIND SPEED vs DIRECTION
FOR
ROCKLAND, MAINE

WRIGHT · PIERCE
CE MAGUIRE, INC.

CEM NO. 4237
FIGURE NO.
2D

b. Summary of Extreme High Tides. A listing of selected maximum stillwater tide heights (measurements taken in protected areas in which waves are dampened out) for Portland is provided in Table 6. The table also indicates the elevation that would be attained if the same tidal flood producing event were to occur at 1975 sea level (see Section 2c). This listing was developed utilizing recorded tide gage data gathered at Portland by the NOS. Data in Table 6 show that the five greatest tide levels occurred during northeasters, while only one listed event was a hurricane. The extratropical storm is clearly the prevalent type of storm affecting the study area and poses the greatest threat of severe tidal flooding. In addition, the NOS has maintained a tide gage at Rockland since 1970. Annual maximum tide levels for Rockland are presented in Table 5a.

c. Tidal Flood Profiles. Profiles of major past tidal floods have been developed along the New England coast. NOS tide gage records and high watermark data gathered between gage locations after major storms have been utilized in the development of these profiles. Additionally, profiles of storm tides of selected frequencies have been developed utilizing frequency distributions at tide gages and high watermark information. Location maps and profiles for South End Beach are shown on Plates 1 and 2.

d. Tidal Flood Frequency. A tide stage-frequency relationship for Portland, Maine has been developed utilizing a Pearson Type III distribution function using expected probability adjustment for analysis of adjusted annual maximum stillwater tide levels. Utilizing tidal flood profile data for Rockland, a stage correlation with Portland was developed. Using this correlation and the Portland frequency curve, a tidal flood frequency relationship for South End Beach was estimated (Figure 3).

It should be noted that the NOS has maintained a tide gage at Rockland since 1970, but the record at this gage is not long enough to support valid statistical analysis. Readings from this gage, however, were used in fitting the previously mentioned tidal flood profiles.

TABLE 5

SELECTED MAXIMUM STILLWATER TIDE HEIGHTS
PORTLAND, MAINE (1912-1983)

Date	Observed Elevation (ft.NGVD)	Adjusted* Elevation (ft.NGVD)	Recurrence** Interval (years)
7 Feb 1978	9.6	9.6	100
9 Jan 1978	9.4	9.4	63
30 Nov 1944	8.7	8.9	18
20 Nov 1945	8.7	8.9	18
16 Mar 1976	8.7	8.7	13
7 Apr 1958	8.5	8.6	10
29 Dec 1959	8.5	8.6	10
19 Feb 1972	8.5	8.5	8
28 Jan 1979	8.5	8.5	8
4 Mar 1931	8.4	8.8	15
21 Apr 1940	8.2	8.5	8
20 Jan 1961	8.2	8.3	5
6 Apr 1977	8.2	8.2	4
2 Nov 1963	8.1	8.2	4
20 Nov 1972	8.1	8.1	3
4 Apr 1973	8.1	8.1	3
21 Dec 1976	8.1	8.1	3
19 Nov 1918	8.0	8.5	8
7 Dec 1919	8.0	8.5	8
26 Oct 1980	8.0	8.0	3
10 Jan 1982	8.0	8.0	3
31 Aug 1954***	7.9	8.1	3
21 Dec 1960	7.9	8.0	3
16 Apr 1961	7.9	8.0	3
23 Dec 1968	7.9	8.0	3
14 Apr 1972	7.9	7.9	3
11 Dec 1950	7.8	8.0	3
13 Apr 1953	7.8	8.0	3
25 Oct 1953	7.8	8.0	3
11 Dec 1969	7.8	7.9	3
18 Mar 1972	7.8	7.8	2
2 Dec 1974	7.8	7.8	2
7 Mar 1981	7.8	7.8	2
24 Dec 1981	7.8	7.8	2

* Observed values after adjustment for rising sea level; adjustment made to 1975 sea level conditions based on NOS publication "Trends and Variability of Yearly Mean Sea Level, 1893-1972."

** Recurrence interval of adjusted tide elevations using expected probability adjustment.

*** Hurricane "Carol"

TABLE 5a

ANNUAL MAXIMUM TIDE LEVELS
ROCKLAND, MAINE

Date	Observed Elevation (ft.NGVD)
17 Aug 1970	7.5
24 Apr 1971	7.7
14 Apr 1972	7.9
11 Dec 1973	8.0
7 Feb 1974	8.0
25 Feb 1975	7.7
16 Mar 1976	9.1
5 Apr 1977	8.1
7 Feb 1978	9.5
28 Jan 1979	8.7
25 Oct 1980	7.8
10 Dec 1981	8.1
10 Jan 1982	8.4
25 Nov 1983	8.1

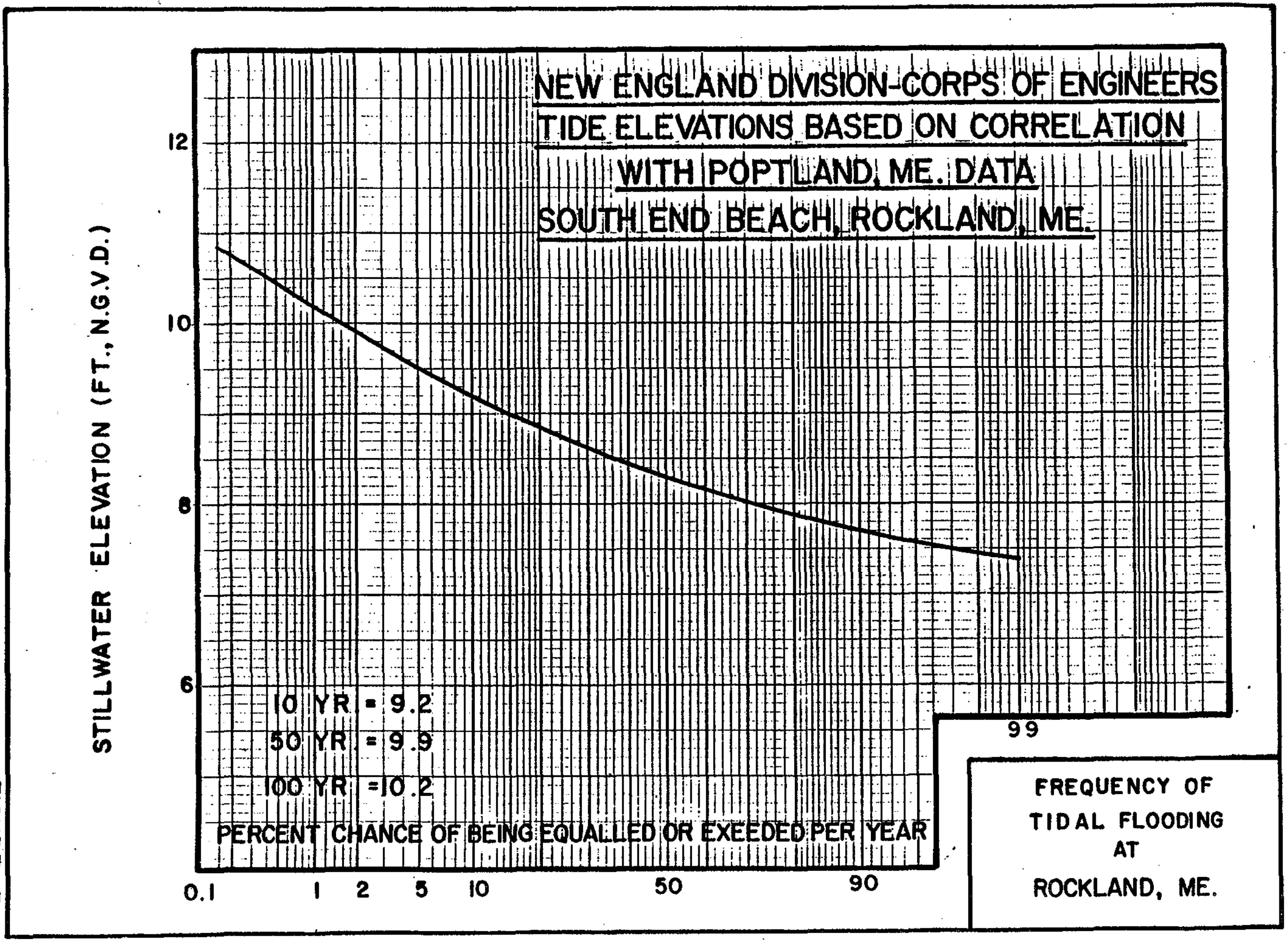
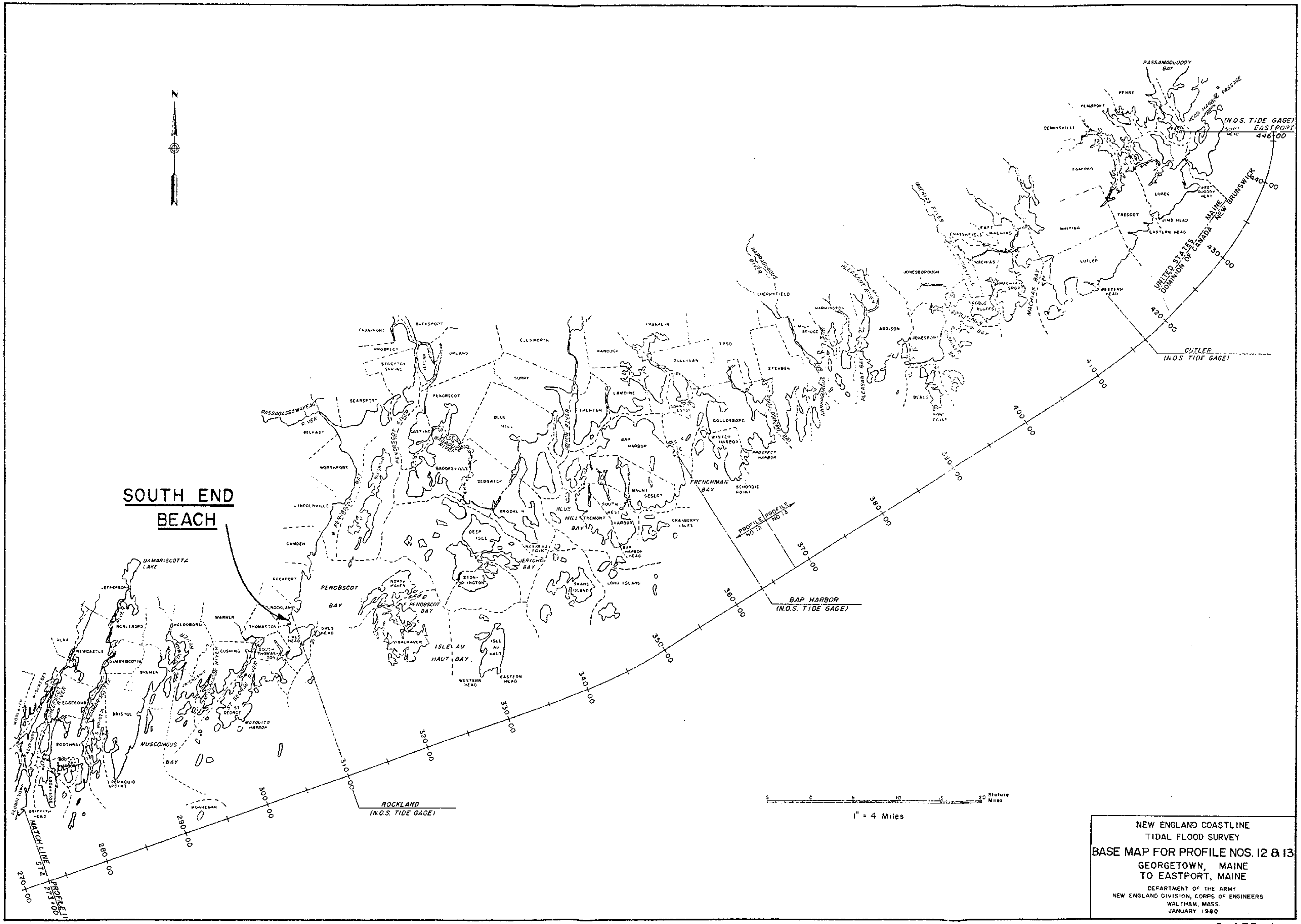

NEW ENGLAND DIVISION-CORPS OF ENGINEERS
TIDE ELEVATIONS BASED ON CORRELATION
WITH POPTLAND, ME. DATA
SOUTH END BEACH, ROCKLAND, ME.
STILLWATER ELEVATION (FT., N.G.V.D.)
12
10
8
6
10 YR = 9.2
50 YR = 9.9
100 YR = 10.2
PERCENT CHANCE OF BEING EQUALLED OR EXEEDED PER YEAR
0.1
1
2
5
10
50
90
99
FREQUENCY OF
TIDAL FLOODING
AT
ROCKLAND, ME.

FIGURE 3

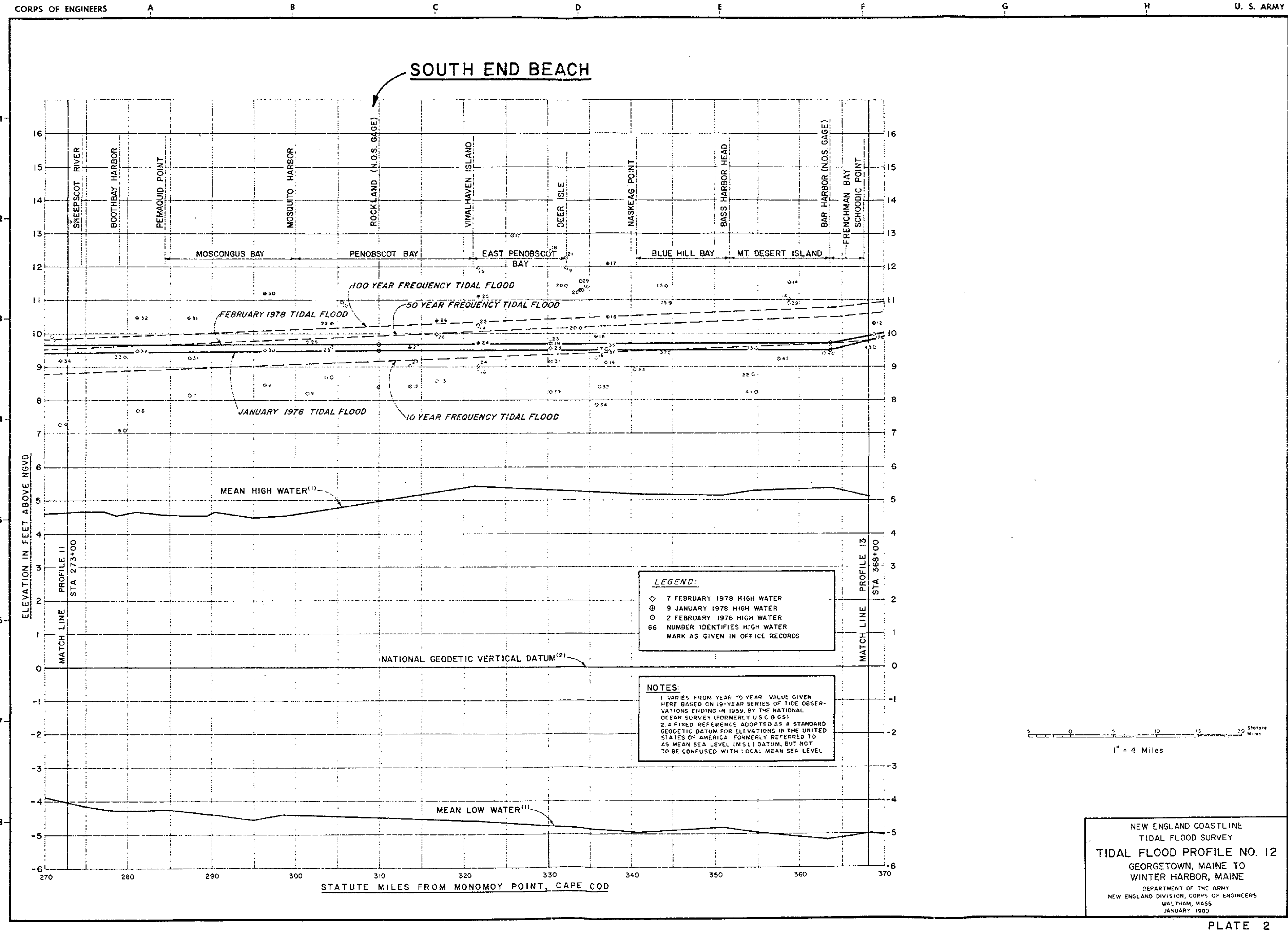
6. SUMMARY

In the preceding sections, astronomical tides were discussed with emphasis on typical tide levels and data conversions for the study area. Sea level rise relative to the land was mentioned. Meteorological factors including storm types and winds were evaluated. Recorded extreme high tides at Rockland were utilized to indicate the combined effect of astronomical tide and storm surge due to wind, wave, and barometric effects on water level. Tidal flood frequency was estimated and tidal flood profiles were presented. This climatic and tidal hydrology information will provide the coastal engineer with essential background information for evaluating erosion processes at the study area and for designing proper corrective measures.



NEW ENGLAND COASTLINE
TIDAL FLOOD SURVEY
BASE MAP FOR PROFILE NOS. 12 & 13
GEORGETOWN, MAINE
TO EASTPORT, MAINE
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
JANUARY 1980

PLATE I



CORPS OF ENGINEERS
U. S. ARMY
SOUTH END BEACH
SHEEPSCOT RIVER
BOOTHBAY HARBOR
PEMAQUID POINT
MOSQUITO HARBOR
ROCKLAND (N.O.S. GAGE)
VINALHAVEN ISLAND
DEER ISLE
NASKEAG POINT
BASS HARBOR HEAD
BAR HARBOR (N.O.S. GAGE)
FRENCHMAN BAY
SCHOODIC POINT
MOSCONGUS BAY
PENOBSCOT BAY
EAST PENOBSCOT BAY
BLUE HILL BAY
MT. DESERT ISLAND
100 YEAR FREQUENCY TIDAL FLOOD
50 YEAR FREQUENCY TIDAL FLOOD
FEBRUARY 1978 TIDAL FLOOD
JANUARY 1978 TIDAL FLOOD
10 YEAR FREQUENCY TIDAL FLOOD
MEAN HIGH WATER(1)
NATIONAL GEODETIC VERTICAL DATUM(2)
MEAN LOW WATER(1)
ELEVATION IN FEET ABOVE NGVD
MATCH LINE PROFILE 11 STA 273+00
MATCH LINE PROFILE 13 STA 368+00
STATUTE MILES FROM MONOMOY POINT, CAPE COD
LEGEND:
◇ 7 FEBRUARY 1978 HIGH WATER
⊕ 9 JANUARY 1978 HIGH WATER
○ 2 FEBRUARY 1976 HIGH WATER
66 NUMBER IDENTIFIES HIGH WATER MARK AS GIVEN IN OFFICE RECORDS
NOTES:
1 VARIES FROM YEAR TO YEAR. VALUE GIVEN HERE BASED ON 19-YEAR SERIES OF TIDE OBSERVATIONS ENDING IN 1959, BY THE NATIONAL OCEAN SURVEY (FORMERLY U.S.C.& G.S.)
2 A FIXED REFERENCE ADOPTED AS A STANDARD GEODETIC DATUM FOR ELEVATIONS IN THE UNITED STATES OF AMERICA. FORMERLY REFERRED TO AS MEAN SEA LEVEL (M.S.L.) DATUM, BUT NOT TO BE CONFUSED WITH LOCAL MEAN SEA LEVEL.
1" = 4 Miles
NEW ENGLAND COASTLINE
TIDAL FLOOD SURVEY
TIDAL FLOOD PROFILE NO. 12
GEORGETOWN, MAINE TO
WINTER HARBOR, MAINE
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS
JANUARY 1980

PLATE 2

APPENDIX 3

GEOLOGY AND COASTAL PROCESSES

APPENDIX 3
COASTAL PROCESSES AND GEOLOGY

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APPENDIX 3

COASTAL PROCESSES AND GEOLOGY

GENERAL

The project area is located along a reach of eroded shoreline fronting a 12-foot high wave-cut bedrock cliff and facing easterly from Rockland Harbor in West Penobscot Bay. The beach consists of fine to coarse sand, gravel and cobbles derived primarily from glacial deposits covering the bedrock and shell fragments. The dry beach width at high tide is approximately 10 feet at the north end and approaches zero at the southern end. An outcrop of bedrock divides the study area into two parts with the north side being somewhat larger than the south side. A steep slope of bedrock partially veneered with glacial sediments rises in back of the shoreline. This section of the report will discuss the geologic setting of the study area.

BEDROCK GEOLOGY

The bedrock underlying the area near Rockland has been mapped as undifferentiated meta-sedimentary rocks of Ordovician-Silurian Age with associated outcrops of metamorphosed volcanics seen locally. A narrow outcrop of calcareous siltstone and limestone is present a few hundred feet inland of the beach. The rocks were formed about 450 million years ago as sediments accumulated to great thickness in ocean basins. The sedimentary rocks so formed were then metamorphosed as the sequence underwent intense folding and uplift. A long period of weathering and erosion followed the metamorphism and deformation of the region. During this time the land generally wore down, the surface was leveled, and the present bedrock topography was sculpted. The period of weathering and erosion was halted about 2 million years ago by the worldwide climatic change which resulted in flows from the north of great masses of ice over Maine and much of the upper portions of North America. This period of glaciation, called the Pleistocene Epoch, has had a significant effect on the present day coastal landforms of the Rockland area.

SURFICIAL GEOLOGY

The unconsolidated sediments lying over the bedrock in the study area are a direct result of the several episodes of glaciation occurring during the Pleistocene. The events of the most recent substage of the Pleistocene, the Wisconsin stage, have had the most immediate effect on the area and are the most confidently inferred from existing field evidence.

The Wisconsin ice began to advance towards the area no more than 100,000 years ago and had completely left Maine approximately 10,000 years ago. As the ice sheet advanced from the north it moved great quantities of previously weathered material with it and further eroded the bedrock surface. The erosion and deposition of the ice sheet shaped and strongly influenced the form of the present day topography.

Ice of the Wisconsin stage reached its maximum advance about 18,000 years ago. Due to incorporation of water into the ice sheet, sea level at the time was substantially lower than at present and the ice advanced into the Gulf of Maine onto the continental shelf. A general climatic warming began approximately 13,000 years ago and the ice sheet began to retreat from southeastern Maine. The rate of retreat of the ice front margin has been estimated at 300 yards per year.

Approximately 13,000 years ago, as the ice retreated from southeastern Maine, the sea level rose in immediate response to the ice melting and advanced inland, flooding the present mainland to a depth of 400 feet above present sea level. During this late glacial time, meltwater streams transported large amounts of fine grained silt and clay in to the ocean where they eventually settled to the bottom. This deposit of fine grained marine sediments has been named the Presumpscot Formation and overlies much of the coastal area of southeastern Maine including the study area. Postglacial emergence or "rebound" of the land has exposed large areas of this glacial marine clay and other fine grained material. Several local readvances of the ice sheet along with late glacial outwash deposits have caused glacial drift to overlie the Presumpscot Formation in several localities. Rising sea level has caused many of these deposits to be flooded. The surficial map of the Rockland quadrangle shows the study area as overlain by the Presumpscot Formation. Several small outcrops of bedrock are exposed and some areas of till are mapped a few thousand feet east and south of the study area. For purpose of this report it is sufficient to note that silts, sand, gravels and cobble of mostly glacial origin are present in and around the study area. It is these eroded and reworked sediments which compose the beaches of the Rockland area.

PRESENT SHORELINE

The present configuration of the beach and its location relative to surrounding land masses and bodies of water is due to several geologic factors including the glacially modified structure and topography of bedrock and the effects of rising sea level. Prior to the advance of the glacial ice over the region the long period of uplift and erosion referred to earlier resulted in a bedrock surface which sloped seaward and was incised by several well developed stream valleys. The surface of the central Maine coast (including specifically that of the Penobscot Bay area) was characterized by hills and moderate highlands separated by stream carved valleys.

As the ice spread over the area, most of the valleys were enlarged by glacial scour. Great meltwater streams draining the wasting glaciers at the close of the Wisconsin stage further eroded many of the valleys. The postglacial rise in sea level caused many of the valleys to become flooded. Hills and highlands on previously dry land became isolated islands in bay and coves. Almost the entire Maine coastline took on a very embayed and irregular appearance as the sea advanced landward. Penobscot Bay with its several islands and capes is the result of a major valley system being "drowned" by rising sea level. Rockland Beach is a pocket beach protected by the structurally controlled bedrock outcrops of Owls Head to the south and Jameson Point to the north near the Rockland city boundary.

The geography of Penobscot Bay in the vicinity of Rockland permits only very short fetches of onshore wind to exist. A long breakwater jetty extending south from the previously referred to Jameson Point further limits the effective fetch of the waves advancing to South End Beach. Only winds in an arc ranging from north to east blow onshore at Rockland Beaches. The fetch distances from all these directions except east are less than 2 miles. The maximum fetch distance of 9.6 miles is from the east.

These short fetch distances suggest a low wave regimen and thus only a moderate overall rate of shoreline retreat due to the wave attack. Intense storms of even short duration, however, can cause significant erosion for intermittent periods.

In summary, South End Beach evolved as a result of the several geologic pressures described above. The beach consists of sand, gravel and cobbles derived from erosion of bedrock and reworking of glacial sediments. The beach is situated in a small curving pocket between the bedrock headlands. The fetch distances for onshore winds at South End Beach are short, suggesting only moderate rates of erosion. The fact that some significant erosion has occurred, however, is clearly seen by the lack of dry beach area at high tide and the embankment at the backshore. No historical information is available regarding rate of retreat of the shoreline but it is estimated at 6 to 12 inches per year.

PROPOSED ALTERNATIVES

When viewed from the perspective of geologic time, the dominant trends in shoreline change that have been occurring for thousands of years will continue. The shoreline of South End Beach will continue to retreat inland as sea level rises and erosion from winds and waves continually rework and reshape the configuration of the shoreline. Carefully considered shoreline modifications can, however, result in maximum benefits for the existing coastlines and can slow the rate at which natural changes occur in order to allow for longer term recreational use of the area. This section discusses the impact of the proposed alternatives on the study area. The impacts predicted are based upon the relationship between the given alternative and the shoreline processes discussed previously.

Common to all proposed plans of improvement is the widening at the beach to a level berm of 50 feet in width. This plan would initially have a very positive effects on South End Beach. An enlarged, safer and much more aesthetically pleasing beach would be constructed with excellent potential for recreation. There is, however, a significant probability that the coastal processes operating along the shoreline will in time erode and transport a substantial portion of the nourishment sand. The stronger storm waves which predominate from the easterly direction would tend to move sand offshore and/or alongshore. The more gentle waves from the north will tend to move sand back up on the beach and along the beach to the south by the mechanism of longshore transport.

There is no practical solution to the problem of sand moving on and offshore. In fact, considering the pocket nature of the beach, there is a good possibility that the onshore-offshore movement of sand is in equilibrium and the change would be only one of seasonal variance.

The problem of movement of sand alongshore to the north and south may be at least partially alleviated by the judicious placing of structures. A pile of rubble is presently in position at the north end of the beach. Given the shape of the beach and the lack of any significant waves impacting the beach from a southerly direction, it is reasonable to assume that no further structure is needed at the north end of the beach. The problem of sand moving southerly may be solved, for the lifetime of the project, by the construction of a groin at the southern one-third of the beach. This groin would in effect, divide the beach into two segments. The northerly, larger segment, would retain sand between the rubble at the north end and the constructed groin. The smaller, southerly segment would be protected by the constructed groin at its north margin and a natural bedrock outcrop at its southerly margin.

This combination of nourished sand and the construction of a groin is described as concept one in the main report. Because this plan best meets the goal of the project and best seems to fit in with the coastal processes acting in the area, it is considered as the recommended plan.

SUMMARY

Various analysis of wind data and the use of wave forecast curves allow the projection of the occurance of certain wave heights at South End Beach. The results of these analyses and selection of design wave data, indicate that the prevailing wave climate at South End Beach is one of generally low energy. Most winds are of the more gentle variety and the great majority of waves are less than 2 feet in height. Winds and waves from the easterly direction have significant more energy and impact on the beach because of the frequency of the storm winds from this direction and the relatively long fetch to the east. Analysis of wind velocity data show that significant and/or design wave height for a 5-year wind return period from the east is 4.4 feet (see Appendix 2 and Appendix 4). The erosion caused by these stronger waves in combination with rising sea level have reduced the dry beach area and warrant the consideration of selected plans of improvements.

APPENDIX 4

ENGINEERING DESIGN INVESTIGATION
AND
COST ESTIMATES

APPENDIX 4

ENGINEERING DESIGN INVESTIGATION
AND COST ESTIMATES

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APPENDIX 4

ENGINEERING DESIGN INVESTIGATION AND COST ESTIMATES

INTRODUCTION

Preliminary analysis, as shown in the main report, eliminated the alternative erosion control measures of a revetment, an offshore breakwater, and nonstructural plans. The only feasible method of controlling erosion involves the re-establishment of a protective beach probably with an associated groin or groins. This appendix addresses the design elements required.

DESIGN WAVE

The primary erosive forces acting on the shore are waves generated by winds, particularly the waves generated by storms. The size of a wind wave is determined by the velocity of the wind, the duration of the wind and the unobstructed overwater distance, or fetch, over which the wind acts. A given wind speed with unlimited duration and fetch develops waves to a limiting maximum height and associated period and energy. Beyond this limit, known as a fully developed sea, turbulence, breaking and energy loss balance the energy input from the wind and there is no further growth. A fully developed sea may not be reached if wind duration or fetch length are not sufficient.

At South End Beach the maximum fetch is 9.8 miles east toward Vinalhaven Island. The fetch is limited to a 22° arc from Owls Head on the south and Rockland Breakwater at the north. The average fetch through this narrow opening is 9.3 miles. There is also a minor fetch within the harbor to the NNE of 1.6 miles (see Figure 10 - Main Report).

A suitable wind velocity must be selected based upon some return frequency applicable for the type of project. In the case of South End Beach a return period was chosen to be 5 years for analysis of the beach fill which must conform to natural processes to perform its protective function. A larger return period was investigated for groin structures. The static structures involving heavy stone are generally better designed for a more severe wave climate to minimize the more difficult and expensive maintenance required if they are damaged.

The necessary wind data is included in Appendix 2. The method used in determining the design wave is that recommended by ETL 1110-2-305, dated 16 February 1984. Based on this data the wave heights for winds of various durations with a return period of 5 years were developed for a average fetch of 9.3 miles.

Table 1
Winds and Waves - 5 Year Return, 9.3 Mile Fetch

Duration (HRS)	Velocity (MPH)	Wave Height (FT)	Limit
1	36	2.7	Duration
2	33	4.4	Fetch/Duration
3	31	3.8	Fetch
4	29	3.9	Fetch
6	26	3.0	Fetch
8	27	3.1	Fetch
12	22	2.5	Fetch

Based on this it is obvious that the design wave for a 5-year return period is 4.4 feet. This wave would have an associated period of 4.2 seconds.

Utilizing the methods of the 1984 Shore Protection Manual (SPM), the breaking depth and runup for this wave were determined. Breaking depth would be an approximately 5.6 feet of water and runup on a 1-vertical to 15-horizontal (1V:15H) slope similar to the present South End Beach would be 1.4 feet above the still water elevation. The SPM methods, however, are for smooth impermeable beach slopes. A coarse, permeable beach face, as at South End, would significantly reduce runup. The above figure is therefore, conservative.

DESIGN TIDE

Based upon the data presented in Appendix 2 a tidal flood elevation for a 5-year return frequency is +13.4 MLW. However, noting that the project life is 50 years and that there is a sea level rise of approximately 0.01 foot per year a somewhat more practical design tide elevation of +13.9 MLW is recommended. This corresponds to a present 10-year tidal flood return period and conveniently accounts for sea level rise over the 50-year evaluated project life.

GRAIN SIZE ANALYSIS

A series of samples for grain size analysis were taken at the locations shown in Figure 3, main report. A composite plot of the results are shown in Figure 15, main report.

Sample 3-1, located above the mean high water marks shows a greater amount of fines than the samples on the beach face and is primarily fine to medium sand with some coarse gravel and an absence of coarse sand to fine gravel. The three samples on the beach face between MHW and MLW, however, are poorly sorted fine sand to coarse gravel, with the bulk of the material in the range of medium to fine gravel.

The specific gravity of samples 3-2 and 3-3 was determined to be 2.69, somewhat higher than would be expected for a typical quartz sand.

By visual observations the beach material appeared to have a high shell content. A laboratory test was therefore performed on sample 3-3 to determine this. The results indicated 38.5 percent of the sample by weight was shell fragments. This indicated that while bank erosion supplies most of the beach material, particulary the coarser material, the adjacent mussel beds and other shellfish areas are a significant source of beach material. Shell material typically has a specific gravity in the range of 2.69. The shell material is more easily abraded and eventually lost but is naturally replenished from the adjacent mussel beds.

The size of the material found on the beach is typical of a much steeper beach than presently exists. SPM data is for a sand beach only and does not cover grain sizes typical of South End Beach. The medium grain at South End Beach on the beach slope ranges from 1.3 to 3.0 mm. Work done by Shephard (1963) and McLean and Kirck (1969) on coarse sand beaches indicate that the size material found on South End Beach would have a slope in the range of 1V to 5 to 10H.

In choosing a beachfill standard practice is to attempt to achieve an equilibrium between the fill and natural processes by using fill closest to the existing gradation. It is proposed that this be accomplished at South End Beach by utilizing local sources of borrow. Initial discussions with a local supplier and a contractor experienced in waterfront construction indicated suitable material is available or can be mixed to any reasonable specifications. A proposed grain size distribution is shown in Figure 4-1 superimposed on the existing gradations.

If a coarser grade of material for the southern end of the beach is used to minimize the impact on the rocky intertidal area, the proposed size gradation for the 1V:7H slope is shown in Figure 4-2.

BERM ELEVATION AND WIDTH

Based upon the previously developed design tide and wave, a berm elevation of +15' MLW is recommended with a width of 50 feet. This elevation is slightly above the initial 5-year return flood elevation with a conservative runup imposed upon it. The 50-foot width is considered adequate to supply reasonable protection to minimize backland erosion and still provide a significant improvement in recreational use of the beach.

GROINS

Groins are considered in Plans 1 and 2. In Plan 1 there would be a single groin to prevent sandfill from covering the productive rocky intertidal area. In considering the design of this groin, the feasibility of designing it for a longer storm return frequency in order to minimize more difficult and expensive maintenance of such a structure was investigated. In addition a longer groin maintenance period would minimize environmental disruption by construction equipment.

In design of a groin the significant design parameter is wave size and whether or not the wave is breaking. Since the evaluated project life is 50 years, the maximum wave for a 50-year return was determined to be 5.5 feet. As a groin exists in the intertidal zone, a breaking wave condition is appropriate. Based on this and the methods of the Shore Protection Manual, a K_d factor of 2 for rough quarrystone and one layer of armor, a recommended stone size of approximately 2,300 pounds was determined. If the 5-year design wave were used, the required stone size would be approximately 1,200 pounds. In terms of size, there would be cubes approximately 2.4 feet and 1.9 feet on edge, respectively. The larger-size stone is capable of being handled effectively by the same equipment that would handle the smaller stone and should effectively eliminate groin maintenance over the life of the project. The larger stone size with a range from 2,000 to 3,000 pounds is therefore recommended. A transition layer of stone between the armor stone and core stone is recommended to prevent loss of core stone. The stone for this layer should be in the range of 150 to 300 pounds.

The above assumes side slopes on the groin of 1V:1.5H. This minimum slope, with a crest width of 4 feet was used to minimize environmental impact by providing the smallest practical footprint for the structure. The nose of the groin would slope 1V:2H.

Pile supported barriers are not practical due to the shallow bedrock which would preclude adequate embedment.

Because the primary function of the south groin would be to prevent sand movement into the intertidal area, it is proposed to have a top elevation 1 foot higher than the proposed north beach elevation.

The south groin would be located to make use of the existing bedrock and thereby reduce the quantity of stone required and minimize substrate impacts. The length of the groin would be approximately 180 feet.

Should a north groin be required, it would be similar in design to the south groin, but at the same elevation as the beachfill. As noted in Appendix 3 the function of such a groin would be to prevent excessive loss of fill to the north because of storm waves. This loss is problematical and the necessity of such a groin is not as clear cut as the need for the southern groin.

The armor stone and transition layer noted above would be protecting core stone in the range of 3 to 6 inches. The bearing capacity of the coarse sand and gravel is adequate for the groin structure but long-term settlement is possible due to the finer base material working its way into the core stone. The results would be a slow settlement probably with no significant dislocation of armor stone. The most effective and economical way to prevent this is to place a layer of filter fabric beneath the groin. This would prevent the migration of the finer materials into the groin. It can be configured into bulbs for toe scour protection at the edges of the groin. A typical groin section is shown in Figure 4-3.

SAND LOSS AND RENOURISHMENT

There is no effective way of determining sand loss; but based on experience, reasonable assumptions can be made.

Sound End Beach is a pocket beach with maximum exposure to the east. Wave action for storms is directly onshore with relatively small littoral currents. Sand movement should, therefore, be primarily onshore and offshore. It has been estimated, using a method presented in the May 1985 ASCE Waterways Journal by Birkmeir, that the zone of active sediment transport at South End Beach would extend to a depth of approximately -5 feet MLW. This depth is within the limits of the headlands north and south of the beach so no sandfill should be totally lost to the system.

Sand loss would occur, primarily during the construction phase, but would continue at a reduced rate over the years. The sand loss would diminish the protective and recreational benefit to the beach in that it would be transported to shallow water and not restored to the higher beach levels. The presence of the groins would reduce this loss. It is estimated that with no groin approximately 4 percent of the fill might be lost each year; whereas with one groin the estimate is 2 percent and 1 percent with two groins. Given the lack of an acceptable procedure for determining such loss, a monitoring program would be essential to record what actually occurs on the beach. Construction loss is estimated at 5 percent but construction measures noted below may reduce this.

CONSTRUCTION CONSIDERATIONS

A beach protects the shoreline by providing a sloping foreshore to dissipate energy and sacrificial material to be eroded in preference to the back land. Ease of construction requires that fill material be placed above MLW. Since the beach slope must continue below this level, it is in effect necessary to overbuild the beach and allow natural processess to distribute the material. Waves are more easily able to attack this new, steep slope of very loose material and cause rapid slumping, thereby placing large volumes of fill in suspension. This is particularly the case where fill is dumped from the backshore and progressively carried seaward. Waves continually attack newly dumped material. It is recommended that the filling proceed from the MLW line inland. The first filling would provide a dike along the foreshore which would retard attack on material being placed behind and begin forming the protective new beach slope immediately. The estimated full volume of material would be built-up behind the foreshore barrier as rapidly as possible. This method would allow a more gradual and natural redistribution of fill.

The groin would be constructed by trucks, backhoe and crane operating from the beach. Access would be by a temporary access ramp. It would proceed from the shore and outward by grading and excavating as required, placement of fabric base and toe, dumping and shaping of core stone and placement of armor units. Each operation following closely behind the other.

COST ESTIMATE

The cost estimates included herein are based upon the descriptions above and in the main report. In summary all concepts include a protective beach with a berm width of 50 feet at elevation +15 MLW. If a south groin were added, the slope at the beach face on the north beach would be 1V:15H, while the south beach would have a 1V:7H slope using a coarser grade of sand. If no groin were added, the slope would be 1V:15H over the entire beach. The typical plan and sections are illustrated in Figures 16 to 18 of the main report.

The costs are based on similar NED studies in the area and discussions with local sand and gravel suppliers and a local marine contractor. Their implications are discussed in the economic sections of this report.

Table 2
SOUTH END BEACH
COST ESTIMATE
PLAN 1
(Sandfill, south groin and riprap repair)

A. FIRST COST

Sandfill	27,000cy x $ 8/cy	$ 216,000
Stone	2,250 tons x $20/ton	45,000
Remove & reset riprap on Filter fabric & crushed stone		10,000
	Subtotal	$ 271,000
Contingencies		49,000
	Subtotal	$ 320,000
Engineering & Design		40,000
	Subtotal	$ 360,000
Supervision & Administration		40,000
	TOTAL FIRST COST	$ 400,000

B. COST SHARING

Federal (70%)	= $200,000
Non-Federal (30%)	= $ 200,000

C. ANNUAL CHARGES

Federal		
Interest & Amortization:	0.08765 x $200,000	$ 17,500
** Nourishment:	250cy x $9/cy	2,250
	TOTAL FEDERAL/YR	$ 19,750
Non-Federal		
Interest & Amortization:	0.08765 x $200,000	$ 17,500
** Nourishment:	250 cy x $9/cy	2,250
Groin & Riprap Maintenance:	2 tons x $1,000/ton	2,000
	TOTAL NON-FEDERAL/YR	$ 21,750
	TOTAL ANNUAL CHARGES/YR	$ 41,500

** Nourishment = 500cy/year

Table 3
SOUTH END BEACH
COST ESTIMATE
PLAN 2
(Sandfill, north and south groins, and riprap repair)

A. FIRST COST

Sandfill	25,600cy x $8/cy		$ 204,800
Stone	4,710 tons x $20/ton		94,200
Remove & reset riprap on Filter fabric & crushed stone	L.S.		10,000
		Subtotal	$ 309,000
Contingencies			49,000
		Subtotal	$ 358,000
Engineering & Design			40,000
		Subtotal	$ 398,000
Supervision & Administration			40,000
	TOTAL FIRST COST		$ 438,000

B. COST SHARING

Federal	(50%)	= $219,000
Non-Federal	(50%)	= $219,000

C. ANNUAL CHARGES

Federal

Interest & Amortization:	0.08765 x $219,000	$ 19,200
** Nourishment:	150cy x $9/cy	1,350
	TOTAL FEDERAL/YR	$ 20,550

Non-Federal		
Interest & Amortization:	0.08765 x $219,000	$ 19,200
** Nourishment:	150 cy x $9/cy	1,350
Groin Maintenance:	4 tons x $1,000/ton	4,000
	TOTAL NON-FEDERAL/YR	$ 24,550
	TOTAL ANNUAL CHARGES/YR	$ 45,100

** Nourishment = 300 cy/year

Table 4

SOUTH END BEACH

COST ESTIMATE

PLAN 3

(Sandfill and riprap repair)

A. FIRST COST

Sandfill	38,100y x $8/cy	$ 304,800
Stone	100 tons x $20/ton	2,000
Remove 8 reset riprap on filter fabric & crushed stone	L.S.	10,000
	Subtotal	$ 316,800
Contingencies		49,000
	Subtotal	$ 365,800
Engineering & Design		40,000
	Subtotal	$ 405,800
Supervision & Administration		40,000
	TOTAL FIRST COST	$ 446,000

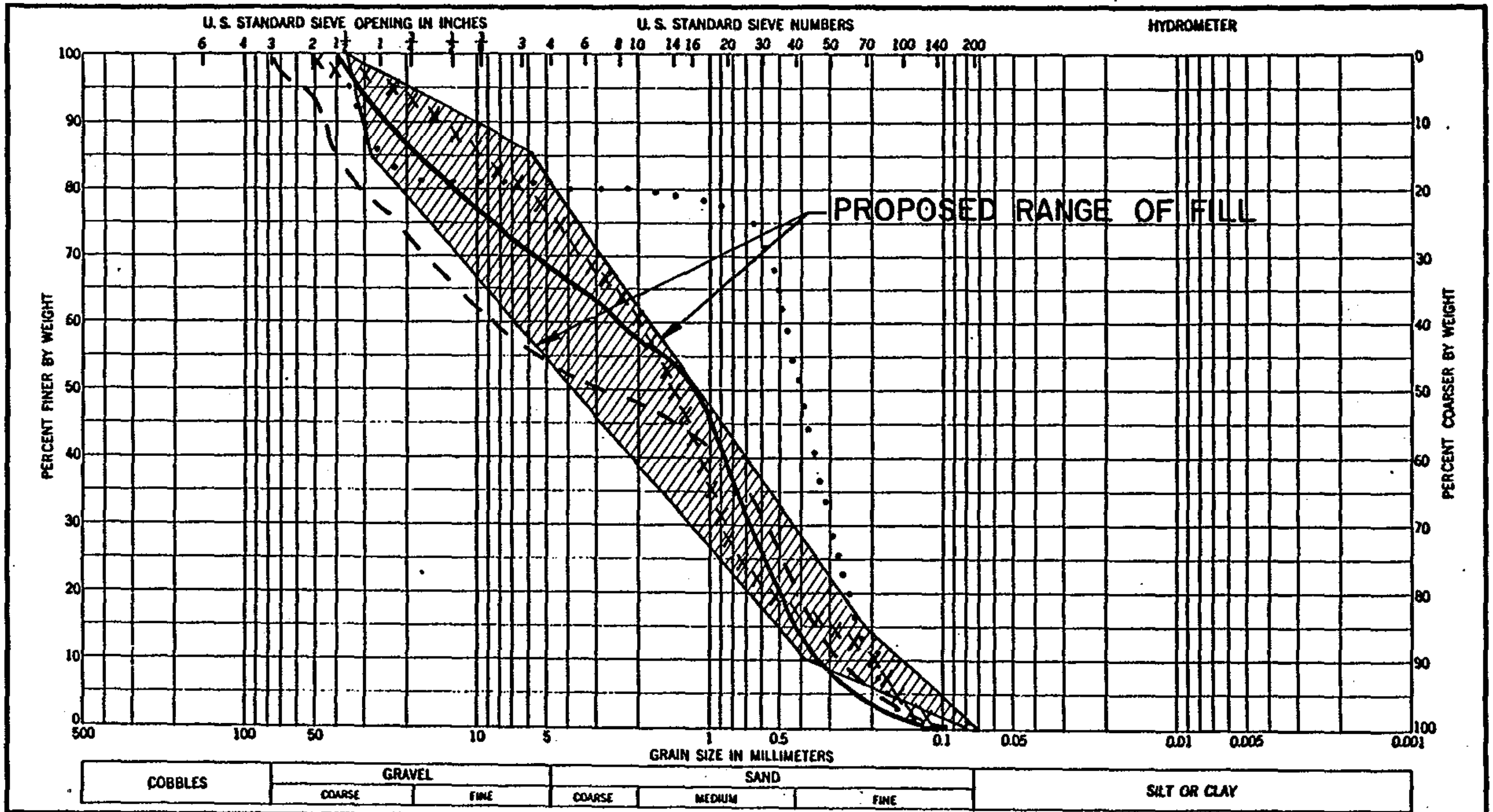
B. COST SHARING

Federal	(50%)	= $223,000
Non-Federal	(50%)	= $223,000

C. ANNUAL CHARGES

Federal		
Interest & Amortization:	0.08765 x $223,000	$ 19,500
** Nourishment:	750 cy x $9/cy	6,750
	TOTAL FEDERAL/YR	$ 26,250
Non-Federal		
Interest & Amortization:	0.08765 x $223,000	$ 19,500
** Nourishment:	750 cy x $9/cy	6,750
	TOTAL NON-FEDERAL/YR	$ 26,250
	TOTAL ANNUAL CHARGES/YR	$ 52,500

** Nourishment = 1,500 cy/year



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3 - 1	SURFACE	• • • • • • • • • • •				
3 - 2	SURFACE	— — — — — — —				
3 - 3	SURFACE	————————				
3 - 4	SURFACE	XXXXXXXXXX				

Project SOUTH END BEACH EROSION STUDY

Area ROCKLAND, MAINE

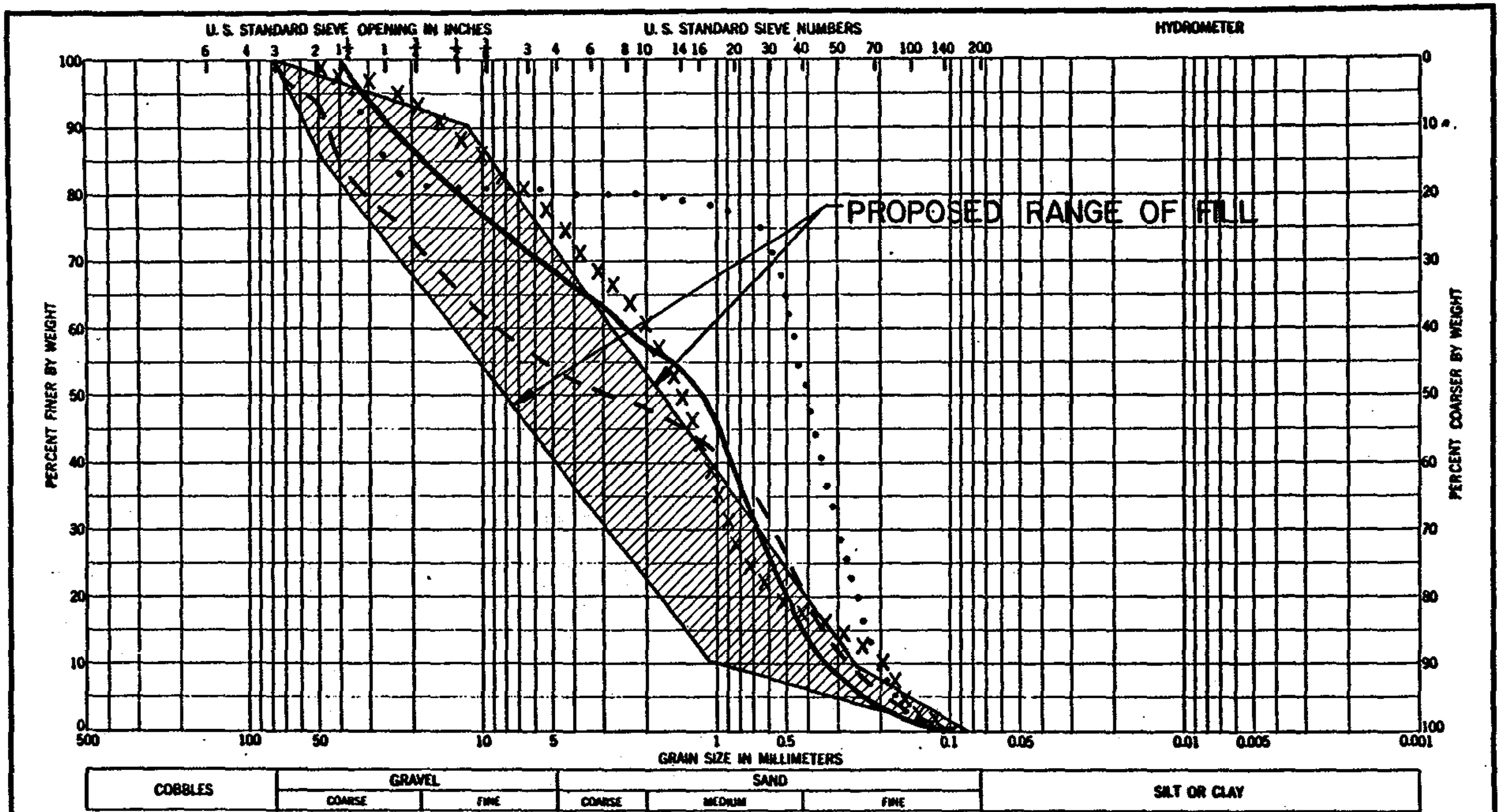
Boring PROPOSED NORTH BEACH FILL

Date

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 4-1



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3 - 1	SURFACE	• • • • • • • • • • • •				
3 - 2	SURFACE	— — — — — — —				
3 - 3	SURFACE	————————				
3 - 4	SURFACE	XXXXXXXXXX				

GRADATION CURVES

Project SOUTH END BEACH
EROSION STUDY

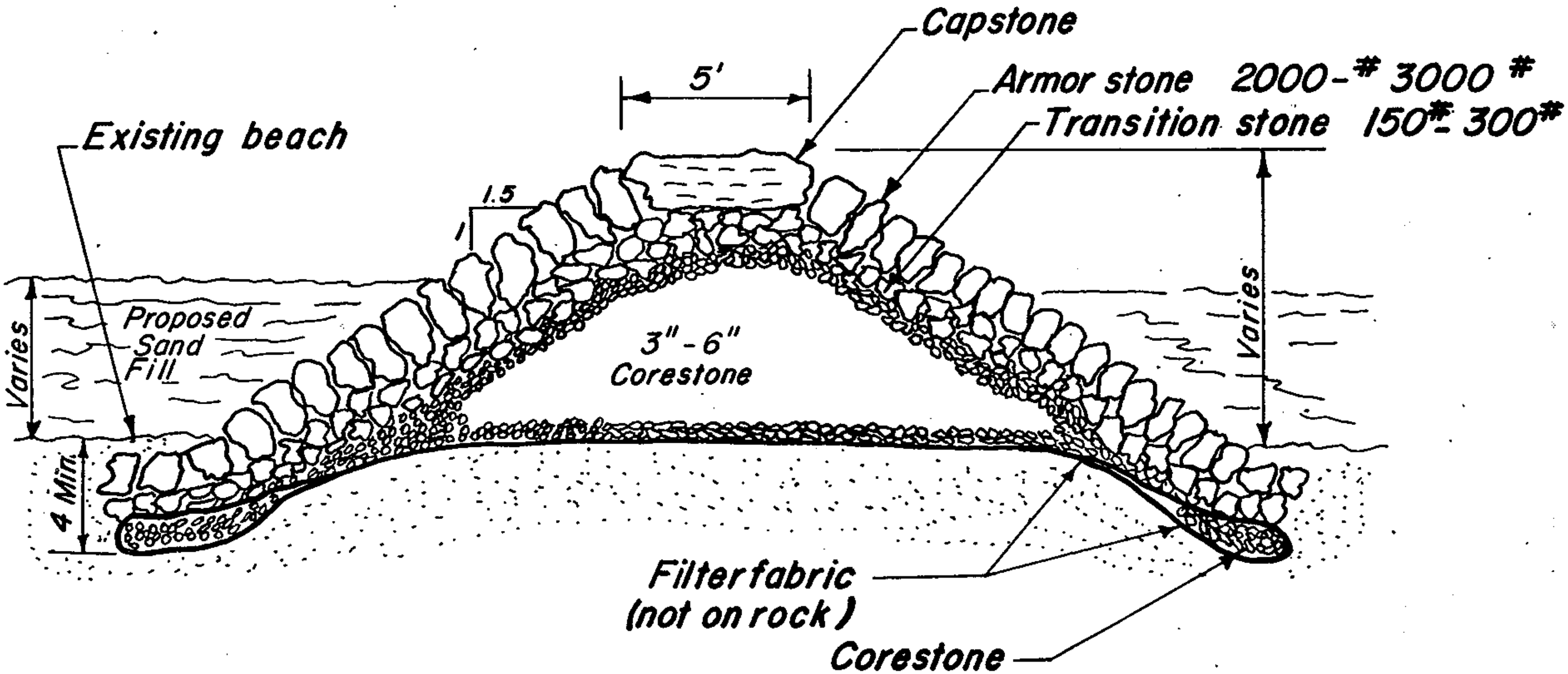
Area ROCKLAND, MAINE

Boring PROPOSED SOUTH BEACH FILL

Date

ENG FORM MAY 63 2087

FIGURE 4-2



TYPICAL GROIN SECTION

NOT ON SCALE

FIGURE 4-3

APPENDIX 5

ECONOMIC ANALYSIS

AND

SOCIO-ECONOMIC IMPACTS

APPENDIX 5
ECONOMIC ANALYSIS
AND SOCIO-ECONOMIC IMPACTS

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Abbreviations

NGVD - National Geodetic Vertical Datum
RLMA - Rockland Labor Market Area

INTRODUCTION

The purpose of this appendix is to evaluate the economic feasibility of the three alternative plans for providing shore protection and recreation at South End Beach in Rockland, Maine with a view to determining the plan which maximizes net contributions to national economic development and therefore allocates Federal resources in the most efficient way. In addition, the social and economic impacts of the alternatives on the inhabitants of the study area are assessed.

The first section contains a description of the study area, followed by present and projected social and economic conditions as related to the alternative shore protection plans. The economic analysis is then presented followed by an analysis of the socio-economic impacts of the alternative plans. The final section is the conclusions of the economic and socio-economic analyses.

EXTENT OF THE SOUTH END BEACH STUDY AREA

South End Beach, is located on the Atlantic Ocean at the southwestern end of Penobscot Bay in the city of Rockland, about 75 miles northeast of Portland. The beach is situated south of the center of Rockland within walking distance of several of the city's neighborhoods and the central business district.

South End Beach is a city-owned property located between an approximately 200-foot frontage along Scott and Ocean Streets on its west and on approximately 450-foot shoreline on the Atlantic Ocean (Penobscot Bay) on its east. At street level the property contains a grassed area with several picnic tables and a Maine Central railway track and easement connected to a lower level beach area by granite steps. The dry beach area at high tide varies from 10 feet of its northern end to a few feet on the south. The beach is bordered on the north by an embankment of large granite blocks on a property owned by the Holmes Packing Company and on the south by ledge outcrops extending from the backshore to the ocean and containing shells and marine life. Further south is a property owned by the Stinson Packing Company containing a bathing area and an embankment area which presently provides offstreet parking to visitors to the South End Beach. This appendix analyses improvements to South End Beach and its extension south to include the beach and embankment area which is presently part of the Stinson property.

South End Beach is essentially a municipal beach having the potential for partially satisfying the demand for ocean swimming in the city of Rockland and several nearby communities. Because of the small size of the beach, the availability of ocean swimming at developed beaches in Camden and Lincolnville and at the undeveloped state beach at Birch Point in Owls Head and a freshwater facility of Lake Chickawaukie in Rockland and the reputation of Rockland as more of a working than recreational city, the beach is unlikely to attract a large number of visitors from towns other than Warren, Thomaston and portions of Owls Head. The study area is therefore comprised of the city of Rockland, the towns of Warren and Thomaston, and a portion of the town of Owls Head. Most visitors from the city would travel between 100 yards and a mile to the beach, although visitors from more remote parts of the study area could travel up to 15 miles.

BASE AND FUTURE CONDITIONS

The conditions described here pertain to the study area but focus principally on the city of Rockland which is the administrative commercial and industrial center for Knox County and beyond. The information presented in this section has been drawn mainly from the document, Rockland Comprehensive Plan, Dec 1983 prepared by the Eastern Mid-Coast Planning Commission in Rockport, Maine.

BRIEF HISTORY

John Lermond built a logging camp in 1767 at the cove in Rockland Harbor which bears his name and shipped staves and lumber. In 1789, lime burning and export began using the limestone from a relatively narrow deposit extending from Thomaston, through Rockland and Rockport into Camden. Eventually, the lime industry, with its Limerock Railroad connecting quarries with waterfront kilns, and also shipbuilding dominated the city. The lime industry declined in favor of cement in the 1930's. Relatively little of the lime industry is left today except for a few wharves and abandoned quarries. Fish processing and canning, which began in the 1820's, and the processing of seaweeds beginning in 1936, have continued to the present day.

Probably the most significant event affecting the South End Beach was the opening of the Rockland wastewater treatment plant in 1978 intercepting outfalls which had discharged wastes into the harbor. The beach, which is located between two fish processing plants, has benefited from the progressive cleanup of Rockland Harbor. People have begun to use the beach and the city organizes activities at the beach as part of its promotional programs for recreation and tourism. The cleaner harbor has been a factor in increased recreational boating and the beginning of harborfront development at the north end of the city.

ECONOMY

Rockland's economy is derived from its harbor, which is one of Maine's largest fishing ports and accounts for about one-third of fish landings in the state. Sardine canning, sea moss extraction and fish meal production are important waterfront activities. Other activities not requiring waterfront location are being encouraged to locate in the city's industrial park at the southwestern end of the city. Regular passenger and freight service from Rockland serves island communities in North Haven, Vinalhaven and Matinicus.

Rockland's industrial economy is composed of a variety of relatively small industries. To the traditional industries, such as ship and boat building and repair and fish processing, have been added in more recent years leathers, apparel, cheese making, metal fabricating and food related industries.

Rockland remains the commercial center of Knox County including its island towns of Vinalhaven, North Haven and Matinicus. Taxable sales in Rockland in 1982 were $76.9 million as compared to $39.9 million for the town of Camden, its closest commercial rival.

POPULATION AND SOCIAL CONDITIONS

Table 1 presents data on population changes in Knox County between 1960 and 1980. During these two decades, the population of Knox County has grown at approximately the same rate as that of the state, or about 15.3 percent. However, the changes within the mainland area of the county have varied from a decline of 9.7 percent for the city of Rockland to an increase of 66.0 percent for the town of Cushing. The differential changes within the county reflect the national trend of a movement from the cities to the suburbs or a suburbanization of the population. The four study area communities grew at 5.6 percent between 1960 and 1980. There are no reasons to expect that future local population changes would be different from the historical trend. Population projections for the area are presented in Table 4.

TABLE 1

Knox County, Maine - Population By City and Town

	1980	1970	1960	Percent Charge 1960 - 1980
Knox County	32,941	29,013	28,575	+ 15.3
Appleton Town	818	628	672	+ 21.7
Camden Town	4,584	4,115	3,988	+ 14.9
Criehaven (unorg.)	5	-	14	- 64.3
Cushing Town	795	522	479	+ 66.0
Friendship Town	1,000	834	806	+ 24.1
Hope Town	730	500	525	+ 39.0
Isle au Haut Town	57	45	68	- 16.2
Matinicus Isle Plantation	66	90	100	- 34.0
North Haven Town	373	399	384	- 2.9
Owls Head Town	1,633	1,281	994	+ 64.3 *
Rockland City	7,919	8,505	8,769	- 9.7 *
Rockport Town	2,749	2,067	1,893	+ 45.2
St. George Town	1,948	1,639	1,588	+ 22.7
South Thomaston Town	1,064	831	732	+ 45.4
Thomaston Town	2,900	2,646	2,780	+ 4.3 *
Union Town	1,569	1,189	1,196	+ 31.2
Vinalhaven Town	1,211	1,135	1,273	- 4.9
Warren Town	2,566	1,864	1,678	+ 52.9 *
Washington Town	954	723	636	+ 50.0

* City and towns in the South End Beach Study Area.
Source: United States National Census 1980

The income of Rockland residents is lower than the average income for residents of the state. Median family and household incomes and per capita income for the state in 1979 were respectively, $16,167, $13,816, and $5,768. Rockland inhabitants achieved 80, 77, and 93 percent respectively of these income levels. The percent of families with incomes below the poverty level exceeded the state average by more than 50 percent. The percentage of residents below the poverty level in the neighborhood immediate to South End Beach is more than double the state average.

According to the report Crime in Maine 1983 prepared by the Maine Department of Public Safety, Rockland has the fourth highest crime rate of any city or town in the state. In 1983, its crime rate per 1,000 persons was 79.78 for index crimes (larceny, burglary, motor vehicle theft, aggravated assault, arson, robbery, rape, and murder) or more than twice the state average. About 96 percent of the crimes were larceny, burglary and motor vehicle theft, of which an estimated 43 percent were committed between June and September.

EMPLOYMENT AND UNEMPLOYMENT

The civilian labor force in the Rockland Labor Market Area (RLMA), consisting of Knox County plus the town of Waldoboro in Lincoln County, has grown at a faster rate in recent years than that of the population.

Rockland employs more than half of the RLMA's civilian employees. In 1980, the number of persons 16 years of age and over seeking employment was 3,307 (of which 14.1 percent were unemployed as compared to 8.4 percent in the RLMA). Besides its high rate of unemployment, Rockland's employment is characterized by its seasonality, particularly in the fish processing industries. Unemployment for the period 1975 to 1983 hovered around the state average. See Table 2.

Table 2
State of Maine and Rockland, ME - Employment and Unemployment

	State of Maine		Rockland Labor Market Area	
	Civilian Labor Force	Percent Unemployment	Civilian Labor Force	Percent Unemployed
1975	456,000	10.3	15,520	10.9
1976	479,000	8.9	16,400	9.8
1977	478,000	8.4	16,120	8.5
1978	483,000	6.1	16,110	5.6
1979	499,000	7.2	17,140	6.9
1980	507,000	7.8	16,870	8.4
1981	509,000	7.2	16,780	7.6
1982	516,000	8.6	17,420	8.8
1983	537,000	9.0	17,940	10.1

Source: Maine Department of Labor, Bureau of Employment Security

LAND USE

The official opening of the Rockland wastewater treatment plant in 1979 signaled the beginning of improved water quality in Rockland Harbor and increased recreational boating activity and bathing. It was also the genesis of harborfront residential development. The Urban Development Action Grant (UDAG) has served to spur a revitalization of downtown Rockland by the creation of additional parking and the improvement of sidewalks, lighting and the installation of benches. The downtown is within walking distance of South End Beach. The Rockland Comprehensive Plan has made the following recommendations with respect to the use of waterfront properties.

- Encourage land use which takes maximum advantage of the natural physical conditions found in Rockland.

- Increase public access to and use of the harbor.

- Encourage use of the waterfront property for water-oriented activities. Use the harbor as a major focus of future tourist-oriented and residential development.

- Retain and encourage existing commercial and industrial activities which require or benefit from waterfront location to remain on the waterfront while directing the relocation of others to more suitable sites in the city. Several industries formerly based at the waterfront have relocated to the city industrial park, about 1 mile to the southwest.

- Remove underutilized waterfront buildings along Main Street, which is located one to three blocks west of the harbor, in order to open views of the harbor to residents, vehiculists and pedestrians.

ECONOMIC ANALYSIS

METHODOLOGY

This economic analysis is based on the procedures accepted by the U.S. Army Corps of Engineers for evaluating the benefits and costs to national economic development (NED) which are associated with the three alternative plans for providing shore protection at South End Beach. These procedures have been established in the reference document:

> U.S. Army Corps of Engineers, Planning Guidance Notebook, Regulation Nos. EP 1105-2-40 (9 July 1983) and EP 1105-2-45 (6 Aug 1984) Planning-Economic Considerations, including Appendix A to ER 1105-2-30, as prepared by the Water Resources Council and entitled, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (18 Oct 1985).

The economic analysis is accomplished by first determining the economic justification of each of the proposed plans in comparing the average annual national economic development (NED) benefits accruing to the project compared to the average annual costs of the project over its evaluated economic life (50 years). Benefits and costs are made comparable by conversion to an equivalent annual basis using an appropriate interest rate. During fiscal year 1986 (1 October 1985 to 30 September 1986) a rate of 8-5.8 percent is employed in the formulation and evaluation of Federal water resources plans and projects. All dollar values in this appendix are expressed in October 1985 prices. For the Federal Government to participate in a project, annual benefits should equal or exceed annual costs.

Secondly, net benefits (annual benefits minus annual costs) are calculated for each project option in order to determine the option that maximizes net benefits and allocates resources in the most efficient manner.

In principle, the evaluation of shore protection benefits may include tangible primary benefits in the following categories:

- prevention of physical damage to land and structures,

- avoided emergency and business costs,

- enhancement of property values, fish and wildlife resources, and

- increased recreational use.

In the case of South End Beach, benefits from the prevention of damage to land and increased recreational use are significant.

PREVENTION OF PHYSICAL DAMAGE TO LAND

In the absence of a plan to improve South End Beach and its southward extension, the present erosion process will continue to result in a loss of land for the city park land, the railroad line and the property currently owned by the Stinson Packing Company. It is estimated that the steep backshore embankment erodes an average of 6 inches per year over a length of approximately 450 feet, although erosion for any particular year may be more or less than the average. During a 50-year period the top of the embankment would recede by about 25 feet. No buildings would be affected. The implementation of any of the beach improvement plans including a common 50-foot wide sandfill berm at 15 feet MLW would dissipate wave energy and provide protection to adjacent backlands. This protective beach would virtually arrest but not eliminate erosion during the life of the proposed improvement.

Benefits derived from the prevention of loss of land are computed as the market value of the average annual area expected to be lost in the absence of a plan. A 6-inch loss of land translates into approximately 0.00516 acres valued at $50,000 per acre or about $300 per year. Since each of the three plans under consideration would provide approximately the same degree of shore protection, each would have annual shore protection benefits of $300.

INCREASED RECREATIONAL USE

1. Beach Space Supply

Rockland, one of the largest fishing ports in Maine, is located within the boundaries of the Eastern Mid-Coast Regional Planning Commission, one of the two commissions within the Mid-Coast Planning District. The April 1983 Maine State Comprehensive Outdoor Recreation Plan (SCORP) indicates that capacity for ocean swimming in the Mid-Coast Planning district is sufficient. While capacity may be sufficient for the entire Mid-Coast Planning District it is insufficient for the Eastern sector of the district.

Existing beach capacity that is publicly owned and developed for recreation is inventoried in the April 1983 SCORP. This information is displayed in Table 3 for the two planning commissions.

Table 3
EXISTING PUBLICLY OWNED AND DEVELOPED
COASTAL BEACHES - MID-COAST PLANNING DISTRICT, MAINE

	Municipality	Name of Beach	Beach Frontage (feet)	Parking Capacity (cars
Southern Planning Commission				
	Phippsburg	Popham	8,300	440
	Georgetown	Reid 1/2 Mile	1,386	800
	Georgetown	Reid Mile	3,432	included in 800 above
	Boothbay	Knicker Kane Island	100	Unknown
	Bristol	Pemaquid	1,485	Unknown
	Bristol	Fish Point	412	Unknown
Subtotal			15,115	
Eastern Planning Commission				
	Camden	Barretts Cove	27	Unknown
	Camden	Lands Ends	50	Unknown
	Lincolnville	Lincolnville	500	Unknown
	Northport	Wyman Park	198	10
Subtotal			775	
TOTAL			15,890	

As demonstrated in Table 3, existing capacity within the Eastern Planning Commission is limited. Of the 15,890 feet of developed public beach frontage only 775 feet or 5 percent is located within the Eastern Planning Commission.

At present, there are no developed public beaches for ocean swimming within the city of Rockland. The nearest such facilities are two small municipal beaches with a total frontage of 77 feet in Camden some 7 miles north of Rockland. However, the nearest developed public beach of significance is the 500-foot long Lincolnville Beach which is some 15 miles away. Communications with local officials indicate that residents of the Rockland area seek ocean swimming at the beaches in Camden, Lincolnville, Birch Point (an undeveloped state beach in the town of Owls Head) and at private and public unsupervised areas in the vicinity of Rockland.

Rockland has received state funding for, and is in the process of establishing a public freshwater beach (550-foot frontage) and facilities on 3.5 acres of land at Chickawaukie Lake on the north side of the city some 2 miles from South End Beach. There is some substitutability between ocean and inland fresh water bathing.

This study assumes that existing swimming facilities in the Rockland area meet one-third of the demand for ocean swimming for the residents of the study area. In addition, it is assumed that if the beach area of South End Beach were improved, an estimated 85 percent of the demand for ocean swimming in the study area would be attracted to it up to the limit of the capacity of the beach and of parking.

2. Beach Space Demand

The estimation of demand for beach space in Rockland is hindered by the fact that no attendance figures are available.

Annual Demand - The only readily available information pertaining to demand is found in the 1983 Statewide Comprehensive Outdoor Recreation Action Program (SCORP) prepared by the Maine Bureau of Parks and Recreation. Based on a survey of recreation and leisure preferences, 21.2 percent of the people in the Mid-Coast Planning District participates in ocean swimming activities away from their backyards or camps. The average number of participation days is 14.7 per year.

Knox County experienced a population growth of 15.6 percent between 1960 and 1980, while growth in the study are was approximately 5.6 percent. It varied from a decline of 9.7 percent for Rockland to an increase of 64.3 percent for Owls Head. Applying these relationships to the study area population (which is expected to grow at the historical rate) yields annual demand estimates for 1985 and 2035 as presented in Table 4. It is likely that the demand for ocean swimming in the study area would not be uniform. Those living closer to the beach, particularly those within walking distance, would visit the beach more frequently than those on the fringes of the study area.

Table 4
South End Beach, Rockland, ME, Study Area
Projections of Population and Annual Demand for Ocean Beach Space

Study Area 1980 Census[1/]	Population (inhabitants) Projections 1985	2000	2035	Annual Demand for Ocean Swimming (Visitor days per year)[2/] 1985	2000	2035
15,300	15,514	16,157	17,778	48,348	50,352	55,403

1/ The population of the study area has its origins in the following:

Rockland	7,919
Warren	2,566
Thomaston	2,900
Owls Head	400
Others in Knox County	1,515
	15,300

2/ Sample calculation for 1985
Visitor - days per year = population x participation rate x participation days per year.

$$48{,}348 = 15{,}514 \times .212 \times 14.7$$

Daily Demand - This analysis assumes that one-third of the demand for ocean swimming in the study area is incompletely satisfied by the limited facilities in Camden, Lincolnville, the undeveloped Birch Point Beach, various private beaches in the study area, or the freshwater facility at Lake Chickawaukie. The assumption for the latter based on a certain substitutability between ocean and freshwater swimming.

Annual demand was broken down to daily demand assuming an 80-day swimming season from late June to early September. This was reduced by 25 percent to account for inclement weather, resulting in a season of 60 good weather days. Of the 60-day season, 35 are considered average days while 25 are considered peak days. It is assumed that demand on peak days is double the demand on average days. Peak and average daily demand for ocean swimming in the South End Beach study area in 1985 are 1,138 and 569 visitors. Assuming that an improved South End Beach would satisfy 85 percent of the demand for ocean swimming, peak and average daily demand would be 967 and 484 visitors, respectively. See Table 5.

Table 5
South End Beach Rockland, ME Study Area
Estimates of Annual and Daily Demand For Ocean
Swimming in 1985 and 2035
(visitor - days)

	1985			2035		
	Daily Demand	Days per Season	Annual Demand	Daily Demand	Days per Season	Annual Demand
Incompletely Satisfied Demand (ISD)						
Peak days	379	25	9,475	435	25	10,875
Average days	190	35	6,650	217	35	7,595
Subtotals			16,125			18,470
Unsatisfied Demand (UD)						
Peak days	759	25	18,975	869	25	21,725
Average days	379	35	13,265	435	35	15,225
Subtotals			32,240			36,950
Total Demand (TD)						
Peak days	1,138	25	28,450	1,304	25	32,600
Average days	569	35	19,915	652	35	22,820
Total			48,348 *			55,420 *

Sample Calculation for 1985

X = ISD

2X = UD

Y = Average day demand

2Y = Peak day demand

TD = x + 2x
43,348 = 3x
x = 16,125 *
2x = 32,240 *

TD = Annual average day demand + annual peak day demand
TD = 35Y + 50Y = 85Y

85Y = 43,348 Y = 569 2Y = 1138

* Rounded

Note: Assuming that South End Beach would satisfy 85 percent of the demand for ocean swimming in the study area yields the following estimates:

	1985		2035	
	Peak Days	Avg. Days	Peak Days	Avg Days
Incompletely satisfied demand	322	162	370	184
Unsatisfied demand	645	322	739	370
Total demand	967	484	1,108	554

3. Benefit Analysis

Recreation Benefits - Annual recreation benefits are determined by subtracting the recreational value under the without-project condition from recreational value with the project. Recreational values are measured in terms of users' willingness to pay for the use of the facilities. The Unit Day Value Demand (UDV) Method is appropriate here since the analysis for South End Beach adheres to the criteria governing its use, i.e., the beach would service general recreation needs for less than 750,000 annual visits at a cost of less than $1,000,000. Applying the guidelines for assigning points for general recreation to the five criteria categories and the conversion of the points to dollar values (see Table VIII 3-2 in the Planning Guidance Notebook) yields 25 points or dollar values of $2.45 for ocean swimmers using existing study area facilities under "without plan conditions."

Under the "with plan conditions", improvements would be made to increase the capacity of South End Beach by extending the public beach further south, raising and widening the dry beach area, and insuring its maintenance and aesthetic appeal. Visitors would use the beach for swimming, sunbathing, picnicking (particularly by people working or living in the area) or for seeking views of the harbor. Plans 1 and 2 would protect the intertidal area to the south of the beach to permit viewing and handling of marine life by visitors. The groins in Plans 1 and 2 would offer opportunities for fishing. For those reasons, Plans 1 and 2 would provide slightly higher value visits than Plan 3. Table 6 summarizes the recreational values for the without-plan condition and conditions for each of the three plans. Table 7 presents the current equivalences between the recreational point and dollar values. Applying the conversion factors yields $3.54, $3.60 and $3.30 respectively for Plans 1, 2 and 3.

Table 6
South End Beach, Rockland, ME
Beach Recreation Points for Visitors in Study Area

	Without Plan	With Plan 1	Plan 2	Plan 3
a. Recreation Experience	2	12	13	10
b. Availability of Opportunity	3	3	3	3
c. Carrying Capacity	1	8	8	8
d. Accessibility	15	15	15	15
e. Environmental quality	4	11	11	9
TOTALS	25	49	50	45

See U.S. Corps of Engineers, Planning Guidance Notebook, Table VIII 3-2, Guidelines for Assigning Point Values for General Recreation

Table 7
Conversion of Points for General Recreation to Dollar Values
Point Values

0	10	20	30	40	50	60
1.70	2.00	2.30	2.60	3.00	3.60	3.90

Source: U.S. Corps of Engineers, Planning Guidance Notebook

Without-Plan Condition - The recreational value under the "without plan condition" assumes that one-third of the demand in the South End Beach study area is met by existing facilities in Rockland, Camden and Lincolnville and at the private and public undeveloped ocean beaches in the area. It is likely that some potential ocean swimmers would substitute freshwater swimming of Lake Chickawaukie for unsatisfied ocean swimming. To simplify the analysis it is assumed that the recreational value without the project presented in Table 8 would remain constant for the period of analysis.

Table 8
South End Beach, Rockland, ME
Recreational Value of Existing Facilities in the
Study Area Without Plans

	Daily Unit Visitors	Recreational Days Value	Per Year	Annual Recreational Value
Peak Days (1985)	322	$2.45	25	$19,722
Average Days (1985)	162	$2.45	35	$13,891
				$33,613

With-Plan Condition - Under the "with plan condition", the benefit analysis assumes that the city would provide the required budget, personnel, structures and equipment to adequately operate, supervise and maintain the beach. The issue of parking is discussed below.

Theoretically an alternative plan with sufficient capacity could satisfy nearly all of the demand or about 85 percent of the demand for ocean swimming in the South End Beach study area. This would represent 967 visitors per peak day and 484 visitors per average day in 1985, and 1,108 visitors per peak day and 554 visitors per average day for the year 2035.

Table 9 presents the recreational values for each improvement plan.

Table 9
South End Beach, Rockland, ME
Recreational Values with Alternative Plans

		Visitors per		Annual Number of		Unit	Annual
Alternative Plans	Capacity (Visitors)	Peak Day	Average Day	Peak Days	Average Days	Day Value	Recreational Value
1985							
1	1,141	967	484	25	35	$3.54	$145,547
2	1,035	967	484	25	35	$3.60	$148,014
3	1,243	967	484	25	35	$3.30	$135,680
1	1,141	1,108	554	25	35	$3.54	$166,699
2	1,035	1,035	518	25	35	$3.60	$158,418*
3	1,243	1,108	554	25	35	$3.30	$155,397
1985 to 2035							
1							$150,634*
2							$150,515*
3							$140,418*

* Plan 2 would be unable to supply sufficient dry beach area to satisfy the demand of 1,108 in 2035. Benefits for Plan 2 are therefore based on the dry beach capacity of 1,035 visitors.

** The number of visitors to South End Beach would increase during the 50-year project life thereby increasing the annual recreational value of each plan. The recreational values in 1985 and 2035 have been converted into equivalent annual values for the entire 50-year period.

Annual Benefits - The recreational benefits of each improvement are simply the differences between the annualized recreational values with each plan and these values without the plans. Recreational benefits are presented in Table 10.

Table 10
South End Beach, Rockland, Me
Annual Recreational Benefits

Alternative Plans	Annual Recreational Value "With Plans"	Annual Recreational Value "Without Plans"	Annual Recreational Benefits
1	$150,634	$33,613	$117,021
2	$150,515	$33,613	$116,902
3	$140,418	$33,613	$106,805

ALTERNATIVE IMPROVEMENT PLANS

The main report addresses the screening process employed to reduce the number of alternative plans to three for impeding erosion and providing recreational opportunities at South End Beach. This process has led to a decision to evaluate the possibility of improving not only South End Beach within the present city property but also its southward extension for some 280 feet to Atlantic Point. The beach and backshore extension is the property of the Stinson Packing Company. The extension could be required or leased from its present owner. This analysis assumes that the beach would be extended to these limits. Each of the alternative plans would provide a dry beach area consisting of a 50-foot wide beach berm sandfill at 15 feet above MLW and sloping towards mean high water on a 15:1 slope. The three plans vary principally in the structures, if any, to be provided:

Plan 1 - In addition to the sandfill described above, Plan 1 includes a single groin to the south in order to retain sand on its north and prevent the covering of the rocky intertidal area to the south which is a habitat for marine life.

Plan 2 - This plan is similar to Plan 1 except that a north groin would be added to protect the north end of the beach.

Plan 3 - This plan is similar to Plan 1 except that there would be no protective groins. In time the southern rocky intertidal area would be covered by sand and become unproductive.

Tables 11 and 12 present respectively the characteristics and the costs of the three plans.

Table 11
South End Beach, Rockland, ME
Characteristics of Alternative Improvement Plans

Plans	Dry Beach Area (ft")	Capacity* (Visitors
1	68,450	1,141
2	62,075	1,035
3	74,550	1,243

*(Assuming each visitor is provided with 75 square feet of beach area, with a daily turnover rate of 1.25.

Table 12
South End Beach, Rockland, ME
Costs of Alternative Improvement Plans

Alternative Plan

1 - Sandfill - Single Groin - Riprap Repair

(1)	First Cost	$400,000	
(2)	Interest during construction (3 mo.)	3,000	
(3)	Investment Cost		$403,000
(4)	Interest plus amortization (8-5/8% @ 50 Yrs)	35,000	
(5)	Annual Maintenance	6,500	
(6)	Total Annual Costs		$41,500

2 - Sandfill - Two Groins - Riprap Repair

(1)	First Cost	$438,000	
(2)	Interest during construction (3 mo.)	3,000	
(3)	Investment Cost		$441,000
(4)	Interest plus amortization (8-5/8% @ 50 Yrs)	38,400	
(5)	Annual Maintenance	6,700	
(6)	Total Annual Costs		$45,100

3 - Sandfill - Riprap Repair

(1)	First Cost	$446,000	
(2)	Interest during construction (3 mo.)	3,000	
(3)	Investment Cost		$449,000
(4)	Interest plus amortization (8-5/8% @ 50 Yrs)	39,000	
(5)	Annual Maintenance	13,500	
(6)	Total Annual Costs		$52,500

Note: First costs include capital costs for beach improvement and for providing facilities for bathing ($100,000) plus 20 percent for contingencies and 8 percent each for engineering/design and supervision/administration. Maintenance costs include costs for sand replenishment and for maintaining the groin and/or riprap structures.

ECONOMIC EVALUATION

Table 13 presents the results of the economic analysis without consideration of constraints such as parking and the capacity of the South End Beach neighborhood to absorb visitors to the beach.

Table 13
South End Beach, Rockland, Me
Economic Evaluation

	PLAN 1	PLAN 2	PLAN 3
Annual Benefits			
Prevention of Land Loss	$300	$300	$300
Recreation	117,000	116,900	$106,800
Total	117,300	117,200	$107,100
Annual Costs	$41,500	$45,100	$52,500
Benefit Cost Ratios	2.8	2.6	2.0
Net Benefits	$75,800	$72,100	$54,600

All plans satisfy the economic feasibility criterion since they have benefit-cost ratios in excess of one. Since Plan 1, the sandfill alternactive with the protective groin towards the south end of the beach has the highest net benefits, it is selected as the most economically efficient plan for providing shore protection and restoration to South End Beach. In the event that the city is required to purchase the beach extension onto the Stinson Packing Company property, the conclusions of the economic analysis would have to be reassessed. Based on the present market value of waterfront property in the area of the beach, the conclusions of this economic analysis would, however, remain intact if it were necessary that the city of Rockland purchase the South End Beach extension.

PARKING CONSIDERATIONS

At present, visitors may arrive at the South End Beach on foot, by bicycle or private automobiles (those requiring parking and those dropping off visitors), by taxi or by regular transportation service organized for senior citizens. Occasionally small youth groups may arrive by van. No mass public transportation system of buses or trains serve the beach.

The number of visitors (non-dropoffs) arriving by automobile and therefore requiring onstreet or offstreet parking was estimated for the years 1985 and 2035 and presented in Table 14. Assuming 3.5 persons per vehicle, estimates were also made of the number of vehicles requiring parking.

Table 14
South End Beach, Rockland, ME
Parking Considerations

Alternative Plans	Visitors Per Peak Days	Number of Visitors Arriving [1/]: on Foot, by Bicycle, Transportation System or Dropoffs	Number of Visitors Arriving [1/]: by Car and Requiring Parking	Number of Cars Required to Transport Visitors [2]
1985				
1	967	483	484	138
2	967	483	484	138
3	967	483	484	138
2035				
1	1,108	554	554	158
2	1,035	517	518	148
3	1,108	554	554	158

1/ Assumes that visitors arriving by automobile constitute one-half of total visitors.

2'/ Assumes 3.5 passengers per automobile

It is estimated that spaces would have to be provided for approximately 140 vehicles after South End Beach is improved. Parking for approximately 100 vehicles would be available on the extended South End Beach property and on a parcel partially owned by the city within walking distance on Marine Street. In addition, the city permits parking on all local streets except areas immediately adjacent to corners. A number of reasonable options are available to the city for dealing with the need for vehicular parking spaces. Assurances should be received from the city that the parking issue would be addressed and effectively resolved.

SOCIO-ECONOMIC IMPACTS

A range of short- and long-term impacts would accrue to residents of the South End Beach area as a result of implementing one of the alternative beach improvement plans. The socio-economic impact assessment applies generally to all of the alternatives.

SHORT-TERM IMPACTS

The short-term impacts of improving South End Beach would primarily be site-specific and negative during the 3-month construction period. These impacts include a temporary increase in air, noise, and water pollution at the sand quarrying and beach construction sites and the disruption of traffic between the source of the sand and the beach. The construction would also interfere with the use of the beach, possibly during the first half of the peak summer season.

LONG-TERM IMPACTS

The long-term socio-econmic impacts of improving South End Beach would be overwhelmingly positive. However, if the city is unable or unwilling to provide an adequate budget and personnel and facilities, including parking, for the management, operation and maintenance of the beach, negative impacts could result. For example, the construction of any of the alternatives would possibly attract between 1,000 and 1,100 visitors on a peak summer day. Without adequate parking, casual parking along the neighborhood streets and available vacant land could create a public nuisance. The area immediate to the beach would increase in economic value to the extent to which the city effectively manages the area and addresses and solves potential problems created by traffic and the congregation of more people in the neighborhood. The beach sandfill, without the protective groin as in Plan 3, would drift and likely cover the intertidal area, thereby impacting negatively on the marine life and limiting on opportunity for a marine educational program for visitors to the beach.

The implementation of one of the alternative plans would have the long-term effect of reducing beach erosion and of providing ocean bathing for about 3,000 residents of the study area who each seek approximately 15 days of ocean bathing per year. The improved beach would serve as a complement to the city's spirited recreational program and to its downtown revitalization project which affects areas within walking distance of South End Beach.

Besides ocean bathing, South End Beach would provide opportunities for sunbathing, views of the harbor, and in the case of Plans 1 and 2, fishing from the groins, and the observation and handling of marine life in the intertidal rock outcrop area at the south end of the beach. This latter area also lends itself to an educational interpretive program for visitors which could be undertaken by the city.

The beach improvement would provide an improved fresh air alternative for those within walking distance of the beach, whether residents or employed at facilities near the area. Many visitors would be low income people who do not process their own private transportation. The number of persons in the immediate vicinity of the beach having incomes below the poverty level is about double the state-wide average.

The existence of an adequate beach could serve to dampen the peak summer crime rate in Rockland, the fourth highest in the state, by providing additional low-cost opportunities for using leisure time. The attraction of an increased number of visitors to the city would increase retail sales and services to benefit the city.

CONCLUSIONS

Among those considered, Plan 1 is the most economically efficient plan for providing shore protection and recreation at South End Beach. Plan 1 includes a 50-foot wide sandfill berm constructed to 15 feet MLW and a single groin to the south of the beach to protect the intertidal area and its marine life. If the city were required to purchase the extension of the present beach to the south, the conclusions of the economic analysis would remain intact.

The social and economic impact assessment of implementing Plan 1 concludes that, while some negative impacts of a short-term and site-specific nature would occur, the long-term socio-economic impacts are overwelmingly positive. This conclusion is conditioned on the assumption that the city of Rockland adequately maintain South End Beach and provide the facilities, including parking, which are commensurate with the beach capacity provided by Plan 1.